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DIAGNOSTIC VALUE AND THERAPEUTIC APPLICATION OF PERUTERINE INSUFFLATION OF THE FALLOPIAN TUBES IN CASES OF STERILITY*

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PERUTERINE tubal insufflation was devised for the specific purpose of determining the patency of the Fallopian tubes. In order to answer this question in cases of sterility, before this method was available, one was obliged to resort to exploratory laparotomy for, in the majority of instances normal tubes are not palpable per vaginam and diseased tubes are so often implicated with diseased ovaries that they are indistinguishable by vaginal touch. In many cases where the tubal factor was not ascertained, operative procedures to relieve sterility could not but fail of their object. Thus all the otherwise technically excellent operations upon the cervix not associated with an abdominal section were futile in the presence of closed Fallopian tubes. Such an experience, to the chagrin of the surgeon and, what is more important, to the disappointment of the patient, was all too commonly encountered.

Attempts to arrive at a non-operative method to determine tubal patency were begun by me in 1914 by experiments on animals. Collargol was injected into the uterus and through it into the tubes. Roentgenograms were then made and the shadowgraphs of the uterus and tubes were studied. It was soon seen that outlines of the tube lumen could be demonstrated. Cary appears to have been the first to try this method clinically. My own experience with peruterine injection of collargol, and of thorium, bromide and iodide solutions, was not favorable. The peritoneal reactions in the patent tube cases were disagreeable. When collargol was employed, inspissation in the tube lumen persisted for some time, an unhappy sequel in cases where the tubes were open. In instances of non-patency, however, no harm could result to the patient.

In gas, instead of the opaque solutions there was at once found the long-sought simple means to determine patency of the tubes. As it developed later, it also proved of diagnostic aid in demonstrating non-patency. The method of peruterine tubal insufflation, or tubal perflation via the uterus, was begun in November, 1919 at Mount Sinai Hospital, New York. The first clinical application was crude but effective. Oxygen was allowed to pass into the peritoneal cavity of a patient who came to the clinic for the relief of sterility. The abdomen was observed closely until it was seen to rise; the patient complained of distention and epigastric pain and, when she stood up, experienced severe pain in the shoulders and in the diaphragmatic

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region. The *x*-ray plates showed very beautifully a general pneumoperitoneum. The quantity of the gas introduced into the peritoneal cavity of this first patient was estimated at about two liters.

From this first experiment were at once learned the necessity for: 1, reducing the amount of gas injected; 2, some manometric control; 3, some means of measuring the volume of gas to be insufflated. Accordingly there were adapted the siphon volumeter and a mercury or spring-type manometer. It was soon found that a diminutive pneumoperitoneum was as easily demonstrable under the diaphragm[1] (subphrenic pneumoperitoneum) by fluoroscopy as the large-sized pneumoperitoneum by the *x*-ray plate. This was a definite improvement because of its clinical applicability in ambulatory cases. Another change was made by substituting CO_2 for oxygen. Carbon dioxide gas is very rapidly absorbed from the peritoneal cavity. When the amount used is 150 c.c. or less, phrenic irritation and shoulder pains are but momentary. By combining these factors, peruterine tubal insufflation became an office procedure. The test requires one or two minutes to carry out completely and within five to ten minutes the patient is ready to leave the office and able to go about her affairs.

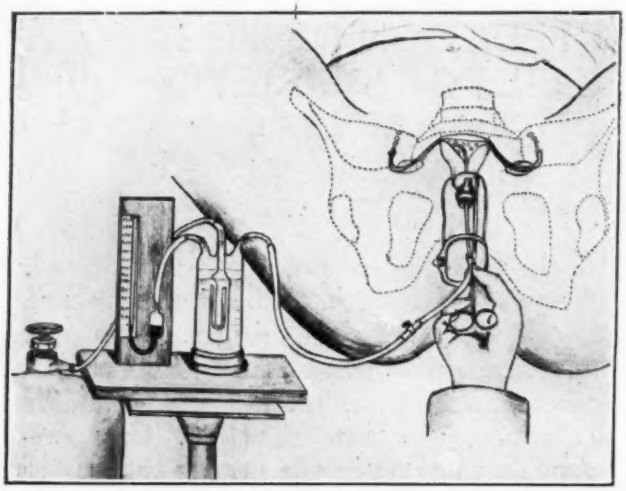

FIG. 1. Uterine cannula and bullet forceps grasping the anterior lip of the cervix, and both held with one hand firmly so that the rubber acorn fits well into the external os of the cervix to prevent leakage from the uterus. The manometer and syphon meter are shown alongside of each other and of an old style oxygen gas tank. The latter three have recently been arranged in a more convenient form, using a much smaller gas tank containing CO_2.

The apparatus (Fig. 1) consists of: a tank containing 100 gallons of CO_2 under one thousand pounds pressure; a reducing gauge; a siphon meter of the type employed in chlorinating water; a manometer (mercury or spring type); rubber tubing connecting the tank through volumeter and manometer to a metal cannula (Keyes-Ultzmann type), fenestrated at its tip; a rubber "acorn" (urethral tip) so fitted over the cannula as to allow the tip to enter well into the uterine cavity while the acorn itself engages the external os and thus prevents premature regurgitation of the gas along the cervical canal; a needle valve between the volumeter and the cannula. In most nullipara the acorn is not important; but in cases of relative sterility where the external os is much dilated through cervical lacerations this rubber "urethral" tip is of great importance to make possible complete air-tightness.

TECHNIQUE

After preparing the genital canal with tincture of iodine as for a surgical procedure, a speculum exposes the cervix. The anterior lip of the cervix is grasped with a tenaculum. Gas is released from the tank and its displacement of the water in the siphon meter is noted. This must not exceed in rate three pulsations per minute. I have found that a time ratio-flow of 15 seconds to raise the mercury column to 100 mm. is the most favorable rate of introduction of the gas into the uterus. It may be slower, that is, it may require a longer time to raise the mercury column to 100 mm., e.g. 20: 25 or 30 seconds, but it should never be less than 15 seconds.

The uniform rate flow of 15 seconds to 100 mmhg. serves as a standard of comparison when several insufflations are

necessary on the same patient. The data obtained are then more readily interpreted. We have thus learned, for example, to distinguish normally patent tubes from hopelessly closed tubes and from stenosed tubes that are amenable to treatment.

Having predetermined this uniform rate-flow of the gas the cannula is inserted into the uterine cavity to a point just below the fundus but well beyond the internal os. The pressure at the cannula tip at the time of introduction into the uterus is zero. This is accomplished by turning the needle valve well open and shutting it tight as soon as one is ready to allow the gas to pass through into the uterus. This moment is synchronous with the beginning of the pulsation in the volumeter, i.e. when the air is seen to approach the bottom of the U within the siphon. That is easily controlled by the operator and he counts the number of pulsations in order to calculate the total amount of gas he wishes to introduce.

For the average patient two pulsations suffice to establish a subphrenic pneumoperitoneum and its associated clinical manifestations. Each pulsation represents 30 to 40 c.c. of gas, as the case may be. The capacity of the gas siphon can be standardized for 30 c.c. or 40 c.c. In obese patients from three to five pulsations may be necessary. The quantity is seldom in excess of 200 c.c.

The manometer is observed in order to determine the point at which the pressure drops. This initial pressure drop indicates the point at which the gas is released through the tubes into the peritoneal cavity. In open tubes this is usually under 100 mmhg. When the tubes are closed the initial drop is not noted and the pressure rises steadily to 200. At this moment the valve at the tank should be shut and observation of the behavior of the mercury manometer should be noted for a few seconds. The cannula and tenaculum are then withdrawn from the uterus. A scant drop or two of blood may be seen to escape from the external os but this is of no significance. The slight ooze from the anterior cervix lip caused by the tenaculum is readily controlled by a cotton tampon which is to be left in for an hour or two. Careful notice is taken of the character and location of the pains produced by the injection of the gas through the uterus for this has definite diagnostic importance.

Fig. 2. Right-sided subphrenic pneumoperitoneum, 100 c.c. of CO_2 gas introduced through the uterus and tubes into the peritoneal cavity.

The patient rises from the examining table and is at once fluoroscoped. If the tubes are patent it will be possible to demonstrate with uniform regularity the presence of a single or double sided subphrenic pneumoperitoneum (Fig. 2). If this be appreciable the patient will voluntarily state that she has pains in one or both shoulders. This latter symptom depends on the one hand upon the amount of gas introduced, and on the other hand upon the sensitiveness of the patient. Hypersensitive patients will notice the shoulder pains at once; phlegmatic patients

may not notice them at all and only upon being directly questioned regarding them. Sometimes the pains are experienced after the lapse of a few minutes. In general less gas is required to evoke this symptom are sometimes described as similar to "unwell pains." Pain on the side is seldom experienced. The fluctuations in pressure are said to be due to tubal peristalsis.

2. *Closed Tubes.* If one tube is closed

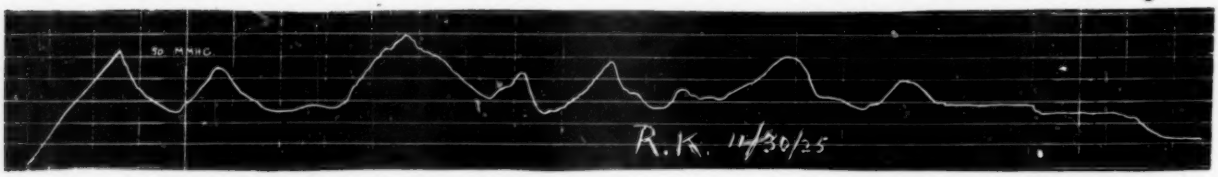

FIG. 3. Kymographic record of normal patency of the Fallopian tubes. The initial pressure rises on the manometer to 50 mm. Hg with fluctuations varying between 60 and 25 mm. Hg as the gas continues to flow through the tubes into the peritoneal cavity.

in thin than in obese individuals. When troublesome, the shoulder pains may be made to disappear instantly by the patient assuming the knee-chest posture. All patients feel well enough to dress and leave the office within a few minutes after the test.

or stenosed and the other normally open, the patient will complain of pain on the side of the tubal obstruction. If both tubes are stenosed or closed the pain is bilateral. This is due to distention of the tubes

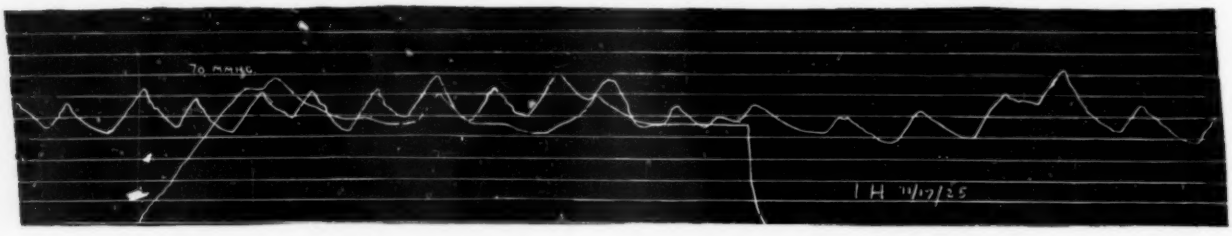

FIG. 4. Kymographic record in case of normal tubal patency showing bilateral subphrenic pneumoperitoneum. The initial pressure rises to 70 mm. Hg and typical fluctuations of the manometer are recorded.

INTERPRETATION OF DATA

1. *Normal Tubes.* The mercury rises to 40, 60, 80 or even 100 mm. and drops 10 to 40 points (Figs. 3, 4, 5), fluctuating several times until the cannula is withdrawn. Usually the patient complains of slight pains referable to the uterus, which

proximal to the point of obstruction and is present whenever the latter is situated at any point beyond the isthmus.

When the manometer rises to 200 mmhg. (Fig. 6) and uterine colic or midline pain referable to the suprasymphyseal area is complained of but no pain on either side, the closure is located at the intramural portion of the tubes or very near the isthmus of each side.

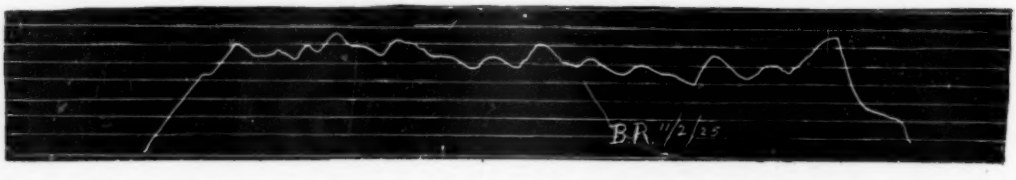

FIG. 5. Kymographic record of another case of normal tubal patency. The initial pressure rises to 60 mm. Hg with the typical fluctuations of manometric pressure indicating tubal peristalsis.

I have found these observations to be practically pathognomonic of the site of obstruction; and I have not had to resort to the injection of opaque solutions into the uterus for this determination. The latter has, however, definite value in cases where operative intervention is decided upon to effect an opening in the closed tubes.

Spasm of the Tubes. There are instances where, after a relatively high pressure is reached, a drop will be noted, indicating that a small amount of gas escapes through a minute opening. As far as my observations have gone they point to the intramural portion and the fimbriated end of the tubes as the predilection site for spasm. Studying this question with the aid of sodium bromide and sodium iodide injections into the uterus, *Kennedy*[2] maintains that he has been able to demonstrate isthmospasm. *Meaker*[3] appears to have indisputably demonstrated tubal spasm by making *x*-ray pictures during injection of CO_2 gas and after a half hour interval. During the gas injection he was able to show a distended tube, which distention was not visible a half hour later.

Recently I have attempted to study by means of the kymograph the behavior of the uterus and tubes during insufflation. The results are interesting and promise to throw light on tubal physiology in the human species. So far, they tend to corroborate the findings of Dr. Snyder and Mr. Seckinger of the Carnegie Institute in Washington, D. C. These authors studied the rhythmic contractions of the freshly removed uterus and tubes from patients at the Johns Hopkins Hospital. From the same laboratory of which George L. Streeter is the director, Ferdinand C. Lee[4] reports some interesting observations bearing upon this question. He injected India ink into the cornu of the uterus directed toward the Fallopian tube. The cat used in the experiment was not in the oestral period, the uterus being small and the ovaries showing no large follicles. He found "that the ink would pass into the tubes but under great difficulty, a pressure of 280 mm. of mercury being frequently necessary in repeated experiments." "On the other hand, in the same animal, injections into the isthmus of the tube directed towards the cornu passed easily into the uterus. However, when the uterus was large and swollen and when relatively large follicles appeared in the ovary, then the passage from uterus to tube was easy. Experiments along the same lines on the dog and guinea pig have so far indicated the same general phenomenon."

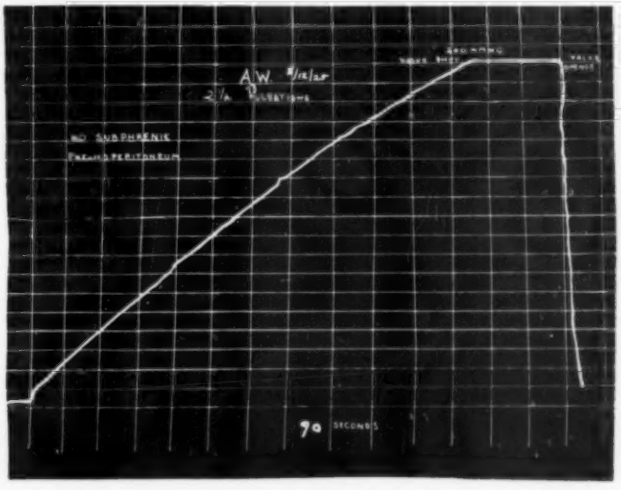

Fig. 6. Kymographic record of non-patency of the Fallopian tubes. The pressure rose to 200 mm. Hg and was maintained at the same level without describing curves on the kymograph. The drop indicates the point where the cannula is removed from the uterus.

"The recent report of Rubin on the various pressures necessary for transuterine insufflation of the tubes at various stages in the intermenstrual period of the same individual, is in harmony with the general principle obtained from work on the lower mammals. It is believed that the uterine end of the tube, through its varying degrees of patency, is to a great extent responsible for the differences in pressure he obtained. Furthermore, the material examined thus far indicates that the greatest patency occurs about the period of ovulation, probably a little before that time."

Evidences of Tube Spasm. The high pressure required to overcome an organic obstruction or stenosis may be distinguished from that due to a tube spasm by the following technique. The cannula is to be held inside of the uterus after the gas has been shut off. If a drop of the mercury is noted and this is not due to regurgitation from the cervical canal, it indicates a possible tubal spasm (Fig. 7) or the overcoming of an exceedingly narrow opening (Fig. 8) at some portion of the tube. Radiographic examination may demonstrate distention of the tube in instances where the stenosis is near the fimbria or at the ampullary portion. Vaginal palpation immediately after the insufflation may demonstrate the distended tube; a few minutes later it becomes impalpable. Auscultation over the lower lateral abdominal areas, a step in the technique as first suggested by Henderson and Amos,[5a] may distinguish the high pitched note of stenosis from a lower pitched note elicited on the normal side. The flouroscopic examination or Roentgen film must show the presence of gas under the diaphragm. In favorable cases the distended tube may also be demonstrated as Meaker[3] has shown. Differential point: if the gas on a second examination enters the peritoneal cavity freely and at a lower pressure it may be safe to assume that the Fallopian tube in that particular case was in spasm at the first insufflation. That this must have clinical importance especially in instances of sterility goes without saying. Further study with the kymograph may

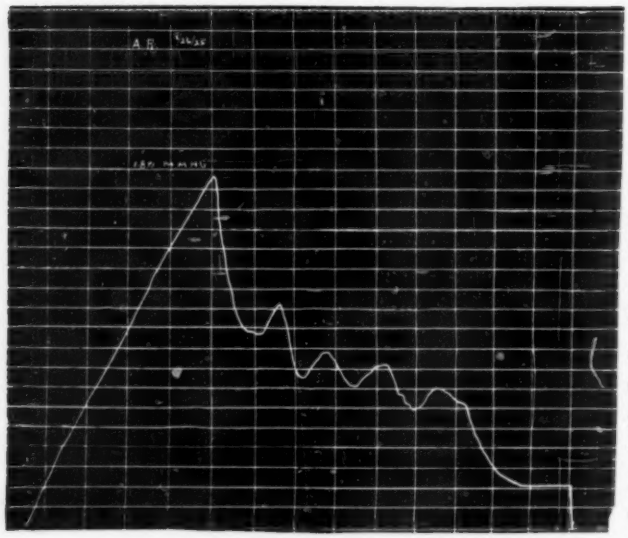

Fig. 7. Kymographic record of case of utero-tubal spasm. The initial pressure rose to 180 mm. Hg, dropping to 100 mm. Hg and gradually reducing as fluctuation waves are recorded on the kymograph.

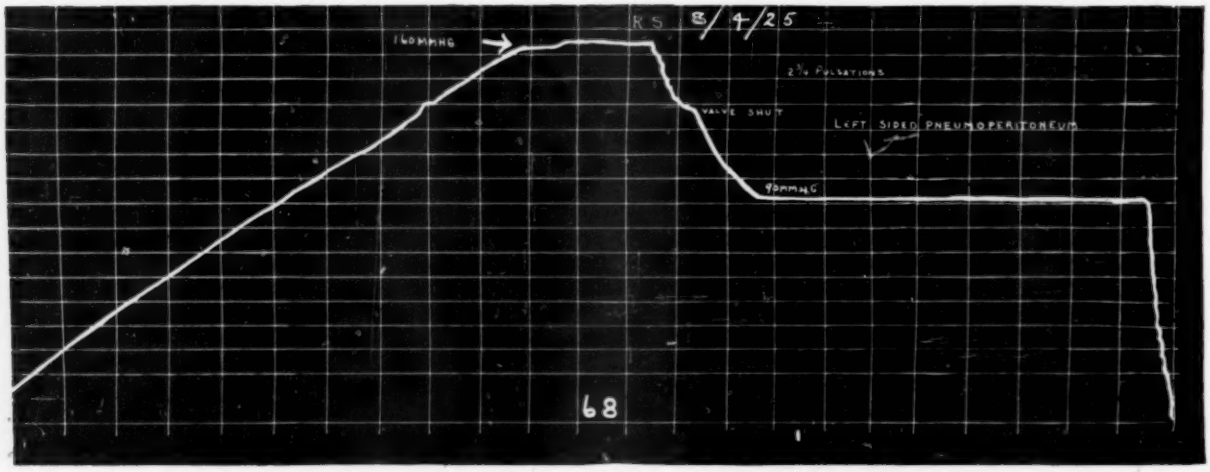

Fig. 8. Kymographic record indicating stricture or stenosis of the Fallopian tubes. The initial pressure rose to 160 and it was maintained without appreciable fluctuations for 51 seconds when a drop was noted but no attempt at describing fluctuation waves on the kymograph was noted. When the tank valve was shut there was a further drop to 90 mmhg. at which point the pressure was maintained for 40 seconds until the cannula was removed from the uterus; the pressure then promptly dropped to zero.

help to establish peculiarities in genital function that have hitherto escaped attention.

SIMPLIFIED METHODS

It must be obvious that any method that does not offer the possibility of studying the question of tubal patency as outlined above must fail in eliciting important data. The most important factor is the uniform pressure-rate-flow and volumetric control. All methods depending upon hand pressure as when the syringe or rubber bulb is employed cannot possibly offer the even flow that can be obtained from a gas tank with an accurate release valve. There are a number of other disadvantages of simplified methods which for lack of time I shall not go into. Only one further point it may not be amiss to emphasize in this connection. Simplified methods of uterine insufflation have encouraged careless employment of the tubal patency test and may perhaps be responsible for disaster in some cases. This does not appear to have been adequately appreciated and I believe the factor of uniform pressure-rate-flow to be of prime importance for the scientific and safe application of peruterine tubal insufflation.

CONTRAINDICATIONS AND DANGERS

The original method of peruterine or "transuterine" tubal insufflation as it was first termed by Peterson[5] is apparently simple enough. It should be carried out in accordance with the rules that careful experiment and established experience have indicated. The patient must present none of the cardinal contraindications. There must be no evidence of pelvic or genital suppuration, no pelvic tenderness, no inflammatory masses, no fever; nor must she be menstruating or bleeding from other causes at the time of insufflation. She must not be a patient who is suffering from serious cardiac, renal, pulmonary or great general metabolic disturbances. These latter conditions clearly forbid any but imperative diagnostic manipulations. As they arise in individuals who, in general, form poor subjects for pregnancy and labor there would seem to be no need or value in subjecting them to the test of tubal patency for diagnosis and therapy.

The dangers incidental to the method may be briefly summarized as due to: 1. Misemployment of the procedure without due regard for the rigid rules of the technique. 2. An unfavorable time with regard to the menstrual cycle. 3. Ill-chosen cases.

It may be said that where the test has been used most extensively and adequately the cases aggregating thousands, no untoward results have been noted. Peterson and Cron, Ward, Aldridge, Meaker, Rongy, Hirst, Hunner, Bonney and many others besides myself have seen no bad effects. However, two fatalities have been reported to me as occurring in New York City, both of them inexcusable. A very careful inquiry into the circumstances of these deaths showed that the operator in each case violated the rules of technique besides improperly selecting the case. In one case death was due to shock induced by a terrific injection of the gas in a woman of forty-two, a para-IV suffering from cardio-renal disease. In the other case death was due to embolism, an excessive amount of gas under great pressure being introduced into the genitals of a patient suffering from multiple fibroids and bilateral pyosalpinx; forcible dilatation of an amputated cervix preceded and curettage followed the insufflation.

The danger from embolism in properly selected cases can be dismissed from consideration if the test is done correctly.

The only possible untoward effects may arise in those infrequent instances of chronic tubal suppuration where the fimbriated end is still patent. As the pus, even in these cases is usually innocuous, the danger from spilling into the peritoneal cavity will not be appreciable. This, of course, presupposes that the test is carried out properly. Absence of tenderness on bimanual examination and absence

of reaction, may be taken as an assurance that the insufflation will not be followed by serious sequelae. In doubtful cases the sedimentation test and observations on the behavior of the temperature for twenty-four hours following the vaginal examination help to diagnose the presence of latent or subacute pelvic inflammation. A routine urethral and cervix smear of each patient treated for sterility adds to the safety and as this is carried out in each case it will help to weed out the infected cases. The iodine disinfections of the cervical canal also aids in reducing sepsis to a negligible minimum.

CHOICE OF TIME

The most favorable time to carry out peruterine tubal insufflation is from four to seven days after the cessation of a menstrual flow. During this time the endometrium is flat, the uterine ostia of the tubes are not obstructed by the swollen endometrium obtaining in the premenstrual phase and there is less apt to be bleeding. Moreover it is the safest time in that it will not interfere with a possibly impregnated ovum. Insemination soon after a post-menstrual insufflation will give the best chance for the spermatozoa to reach the tubes where they may await and impregnate the ovum. Since adopting this rule I have noted a greater incidence of pregnancy.

REPETITION OF THE TEST

Cases in which the tubes are demonstrated to be normally patent do not require a repetition of the test. If a subphrenic pneumoperitoneum is not produced the first time, however, it is well to repeat the insufflation at an interval of a month. Several trials may be made during the one examination but it is preferable to defer the second trial. Three or four tests at the same relative date from successive regular menstrual periods have been carried out. A fifth or sixth trial can do no harm where the patient is anxious for a therapeutic result. Several of my patients proved to have tubal patency on a fourth test and subsequently gave birth to normal children. The second and third tests were done for corroboration of the original findings and for the purpose of formulating a more reliable prognosis. The indication for a plastic operation upon the tubes may at the same time be clearly established.

EFFECT ON THE NEXT MENSTRUAL PERIOD

The next menstrual period is sometimes ushered in two or three days early. Peterson and Cron[6] have called attention to the relief of dysmenorrhea in some cases and I have noted this in quite a number. Slight staining follows the insufflation for a day or two in a fair proportion of the cases but it needs no special attention.

THERAPEUTIC APPLICATION OF PERUTERINE TUBAL INSUFFLATION

From the very outset the method was obviously one that might have therapeutic as well as diagnostic value. Some authors appreciated this possibility and called attention to it. Peterson and Cron were the first to publish a paper on the therapeutic value of transuterine gas inflation.[6] I must say that although in this respect personal observations were accumulating it was not until May 1925 that I was able to report at the meeting of the New York State Medical Association upon 95 cases of pregnancies out of a series of 1000 consecutive insufflations. My chief interest until then was focused upon developing peruterine tubal insufflation as a diagnostic procedure.

Peterson and Cron state that "a number of patients examined for sterility by the Rubin test where the gas had been forced through the tubes, reported that pregnancy had followed without change of other conditions present during the time they have been desirous of children. This led us to send follow-up letters to all women in whom gas had been successfully

forced through the tubes, omitting, naturally, those cases where our investigations had shown that the husbands were the cause of sterility" . . . "at varying periods following the Rubin test 13, or slightly more than one third of those women, became pregnant." Thirty-six out of forty-seven women written to replied to their questionnaire. "Thirty women had never been pregnant. Six women had conceived earlier in their married lives. Since four of the six women who were relatively sterile became pregnant after the passage of gas through the tubes while nine of the thirty who were absolutely sterile conceived after gas inflation it follows that something more than the mere passage of the gas and mechanical opening of the tubes must be considered in trying to explain the reason for the higher per cent of pregnancies in those women who had previously conceived."

"Pregnancies in ten went to full term. Three resulted in spontaneous abortion at the third month. The younger the woman the greater will be her chance of conceiving. All but three became pregnant within six months after inflation (10 cases). Five had only one normal period. The shorter the period of sterility the more quickly pregnancy supervened. None of the cases who conceived were operated on after the inflation and no treatment was instituted."

The analysis of the cases of pregnancy following peruterine tubal insufflation made by these pioneers with this method has formed a basis for comparison with my own experience. In my series of a thousand consecutive private patients seeking relief from sterility, ninety-five became pregnant following tubal perflation, thus demonstrating that this diagnostic test had a therapeutic effect. These patients reported this fact voluntarily, no systematic questionnaire having been sent out. As no complete survey of this series has been made, the future may show the proportion of successful cases to be greater than 9.5%.

There can be no doubt that introducing gas through the uterus and tubes into the peritoneal cavity does help certain women to conceive. The literature contains definite statements in this respect. Rongy was among the first to make special mention of pregnancy following the use of uterine insufflation and reported four pregnancies out of one hundred and fifty-two cases examined by that method.[7] Besides Peterson and Cron's cases S. R. Meaker[8] reports three cases of women married and sterile for two, four and ten years, respectively, in whom pregnancy followed promptly upon the transuterine insufflation of gas. Two became pregnant immediately and the third became pregnant two months after the test. In each case considerable difficulty was encountered in forcing gas through the tubes. This was accomplished in the first attempt in two cases and at the fourth attempt in the third case. Meaker urges, that insufflation should be tried as a routine therapeutic measure in all cases where every factor aside from the tubes has been excluded. In another publication Meaker has collected forty cases, including his own three, of pregnancy following transuterine insufflation.

Discussing Henderson and Amos' article, Cron[9] states that of 58 patients to whom he had sent questionnaires 14 reported pregnancy. The majority became pregnant after one or two months, some after a second inflation. Incidentally, dysmenorrhea was relieved in some cases also.

Heinrich Guthmann[10] reports that of 15 patients on whom peruterine insufflation was done three became pregnant soon after the test. He draws no conclusions.

P. H. Charbonnet[11] reports the case of a woman with a normal menstrual history, married six years without becoming pregnant. Pelvic examination was negative. The gas pressure rose to 200 mm. Hg.; a second attempt resulted in the gas pressure rising to 180 mm. Hg. and suddenly dropping to 130 and 100 mm. Hg. One hundred and twenty c.c. of gas were

used. She missed the following period and was four months pregnant at the time of his report.

Aldridge[12] reports 600 cases examined by the peruterine insufflation. Nine patients who were insufflated became pregnant. Other cases may have occurred but no systematic inquiry had been made. One woman who had been married four years without conceiving required a maximum pressure of 250 mm. Hg. at two trials. She became pregnant soon after the third test which required 180 mm. Hg. Another woman of 32, married eight years, had undergone a resection of the right tube and removal of a right parovarian cyst. On September 21, 1921 she was insufflated, the maximum pressure reaching 120 mm. Hg. On January 10, 1923 she was found to be pregnant fou months.

A third case was that of a woman of 30 married eight years with one child seven years old, became pregnant after the period following insufflation, the maximum pressure being 170 mm. Hg. Another woman of 26, married eight years, with one full-term seven year old child underwent a plastic operation upon her cervix-uteri, resection of the left tube and ventro-suspension, June 26, 1920. Uterine insufflation with maximum pressure of 190 mm. Hg. was performed. (Date not given.) On September 20, 1922 she was five and one-half months pregnant.

A patient of 22, married six years with one full-term five year old child underwent uterine insufflation December 7, 1922, the maximum pressure being 160 mm. Hg. On January 26, 1923 she was dilated and curetted. At her last examination in the follow-up (no date given), she was eight months pregnant.

Hirst and Mayer[13] report three cases in women "who became pregnant so soon after the Rubin test that we are disinclined to view this phenomenon as incidental."

In their first case, a woman of 30 married eight years, who had had a dilatation and curettage for the relief of sterility four years before, on December 12, 1921 underwent a peruterine insufflation and the pressure rose to 150 mm. Hg. Patency of the tubes was proven by the fluoroscope. On February 3, 1922 she was found pregnant.

A second case was that of a woman of 26, married seven years and never pregnant. Dilatation and currettage one year after marriage. The pelvic examination was negative. By insufflation test October 4, 1921 the Fallopian tubes were found patent. In January 1922 she missed her menstrual period and proved to be pregnant.

The third case was a woman of 27 married three years. Dilatation and curettage eighteen months after marriage the uterus being then retroverted. Peruterine insufflation December 27, 1921 indicated non-patency. Before the test was to have been repeated she had missed her period and examination later revealed an undoubted pregnancy. I have had several cases similar to this last-mentioned one of Hirst and Mayer and feel that in these particular instances uterine insufflation exerts a therapeutic influence.

Ottow[14] of Dorpat believes that as a therapeutic measure the procedure is dangerous in the hands of the general practitioner because of the possibility of its lighting up a gonorrhoeal infection. With this view there can be little disagreement except that the careful general practitioner who had acquired the technique of uterine insufflation may safely add this to his general diagnostic armamentarium.

The incidence of pregnancies following the use of peruterine tubal insufflation is greater than the published reports would tend to show.

In November, 1923, I sent out questionnaires to individual operators and clinics using the "transuterine" insufflation apparatus which was made according to my design. Fifty-eight replies were received, thirty-five of which contained more or less complete data and twenty-three gave

scanty data because the method had been but too recently used by the respondents. Of the thirty-five returned questionnaires containing data, twenty-four gave figures with respect to pregnancy following transuterine tubal insufflation. There were fifty-two pregnancies out of a total of 763 patients treated for sterility by the method of uterine insufflation.

These reports are but a few from the published and unpublished records which by now must have reached a substantial number. From them alone several conclusions may be drawn as to the therapeutic value of peruterine tubal insufflation. The cases are properly chosen and serve to illustrate the type that may be benefited by the insufflation. The greater number of the women were married four or more years and the sterility must in all probability have been due to some obstruction in the tubes because of the initial high pressure. (Cases reported by Hirst, Mayer, Aldridge, Charbonnet, Meaker and Mandelstamm.)

Particularly may the test be said to be of therapeutic value when a woman sterile for a period of five years or more becomes pregnant the month following a peruterine insufflation. This therapeutic result may also be ascribed to the test even though two months elapse before pregnancy ensues. If other measures had been tried without avail the insufflation procedure may be presumed to have exercised a therapeutic effect. When the maximum pressure is not in excess of 100 mm. Hg. and pregnancy soon follows it may be a mere coincidence. However, as will be discussed later, the procedure may alter uterine conditions in such manner as to account for the relief of the sterility.

In younger women and those who are married a short time the therapeutic value of the test is problematic. I have a strong reluctance in employing the test on women married less than one year. Yet there are women who for one reason or another urgently appeal for relief from an infertile mating of six months or more. These women, young or old, are not content to wait the traditional period of three or five years before considering themselves sterile. Modern society has so accustomed us to the delayed birth of the first child that we have almost come to accept it as the normal. Yet Matthews Duncan[15] has shown that on the average the first child is born about sixteen months after marriage. Giles,[16] quoting Duncan, is led to the conclusion that when the first year has passed without any sign of pregnancy, an examination should be made to ascertain whether there is any cause. This question as to the time limit that should be set as marking a sterile marriage has engaged the attention of the profession and the laity for a long time.

A couple who have lived according to the normal marital habit, the wife a virgin at the time of marriage and the husband potent and free from venereal infection, may be justified in seeking an explanation for the failure of conception after six months. I shall not go into the conditions that render a woman absolutely sterile; such cases are rare indeed. Generally speaking, there are contributing factors congenital or acquired, which most often are remediable. The examination may reveal no gross or apparent reason for the childlessness though the couple be married six months or sixteen years. In either case they are potentially fertile. Instances of the first child being born from ten to twenty years after marriage are not infrequent and the incidence of first childbirths in the premenopause are also not unknown. These are encountered in women who have long ceased to undergo any treatment for their sterility; some may never have applied for medical relief. Therefore coincidence cannot always be dismissed. If peruterine insufflation in otherwise unsuccessful and apparently hopeless cases facilitates fertility in an increasing number of women it is fair to ascribe to it a therapeutic value equal to other well-established and well-recognized

therapeutic agencies. Especially is this true where a mechanical hindrance has been overcome by the insufflation.

SUMMARY OF PREGNANT CASES FOLLOWING PERUTERINE INSUFFLATION

In the 102 pregnancies occurring in my later series, 21 had been married between five and fifteen years. In 18 cases the marriage was of between three and five years duration and 61 had been married between one and three years. Two were married less than one year. One was a nulliparous woman 40 years old, married three months; and the other a woman of 19 married six months. In each case there was a sufficiently important reason to make them seek advice concerning their infertility. If one applied rigid critique in the analysis of these cases it would have to be admitted that the 18 women who became pregnant after a period of nulliparity of five years or more were aided by peruterine insufflation. Until more data accumulate the five year limit of nulliparity may serve as a criterion.

One hundred and one women became pregnant after peruterine tubal insufflation.

Primary sterility	63 cases
Relative sterility	39 cases
	102 cases

Of the cases of relative sterility there were:

One child sterility	11
One child and one miscarriage	4
One child and two other spontaneous miscarriages	2
One stillbirth	2
Two children by a first marriage	1
One or more spontaneous miscarriages	12
One or more induced abortions	5
Ectopic gestation	2
Total	39

Married one year and under (2 cases)	15
Married between one and two years	32
Married between two and three years	15
Married between three and four years	17
Married between four and five years	11
Married between five and six years	5
Married between six and seven years	4
Married between seven and eight years	5
Married between eight and nine years	3
Married eleven years	2
Married fifteen years	2
Married but number of years unknown	1
Total	102

HOW DOES PERUTERINE INSUFFLATION AID THE STERILE WOMAN?

1. By establishing patency of the genital tract from the external os to the abdominal opening of the Fallopian tubes. Any cervical canal that is patulous to the uterine cannula used in the uterine insufflation is ample for the entrance of spermatozoa. If the external os appears punctate or pinpoint but admits the cannula, this is proof that it is wide enough to allow semen to enter the cervical canal. The cannula at the same time stretches it somewhat, rendering it more patent for a varying period of time. Should coitus take place shortly after this procedure the spermatozoa must have a better opportunity than otherwise of effecting an ascent into the uterine cavity.

2. In some cases a mucous plug not visible at the external os but occupying the deeper portion of the cervical canal is seen to be expelled after the insufflation and on withdrawal of the uterine cannula. I have the impression that the removal of this mucous plug in this manner may be the important factor in some of the successful cases.

3. By separating mild agglutinations of the folds of the tubal mucosa, by straightening out tortuous tubes, especially of the infantile type, by dislodging a mucous inspissation from a narrow to a wider portion of the tube, by actually separating adhesions at the fimbriated end in cases

requiring 150 to 200 mm. Hg. or more, a way is opened for the descending ovum to meet the ascending spermatozoa.

4. Still another factor not be to lost sight of is the psychic impression which peruterine insufflation makes on the patient. Although the exact nervous mechanism is not at present clear there are women who respond to the physical stimulation of peruterine insufflation through the psyche acting upon the autonomic genital apparatus. Whether it induces a certain amount of relaxation in otherwise spastic tubes, the uterine openings of which are practically closed, must await further inquiry. That there actually exists in certain tubes spasm sufficient to close the uterine ostium in a manner similar to the closure of the internal os of the uterus has been recently demonstrated. I have been able to convince myself of the presence of spasm in a fair number of cases and believe that it is very common in the premenstrual or pregravid state and less common in the postmenstrual interval. Overcoming such spasm may be supposed to exert a therapeutic influence at least in some cases.

INDICATIONS FOR PERUTERINE INSUFFLATION

1. Primary sterility, where contributing causes, including those for which the husband might be responsible, have been eliminated and some operative procedure is contemplated. Here it has a definite prognostic as well as diagnostic value.

2. Primary sterility in which the patient is known to have passed through a gonorrheal pelvic infection soon after marriage and is at the time of the inquiry free of pelvic symptoms.

3. Sterility following a pelvic exudate or abscess complicating a puerperium or abortion, with or without the history of an operation and where resolution has apparently taken place.

4. Primary sterility in which the patient had peritonitis of appendicular origin in the premarital or postmarital state, to exclude tubal occlusion by peritoneal adhesions.

5. One-child sterility without the definite history of pelvic infection.

6. After one whole tube and part of another have been removed for hydrosalpinx or pyosalpinx (conservative surgery).

7. After unilateral ectopic pregnancy to determine the patency of the residual tube.

8. After salpingostomy to determine the success of the operation which was calculated to effect an opening of occluded tubes.

9. After sterilization by tube ligation, to test the patency of the tied or severed tubes.

10. After multiple myomectomy in nullipara to make certain that at least the uterine ostium of the tube has been left intact.

11. Sterility of long standing where pelvic masses are palpable and clinically diagnosticated as fibroids or "chronic disease of the adnexa." The test shows whether or not the tubes are open.

12. As a therapeutic measure to eliminate the tubal factor in sterility.

The causes of sterility are too often obscure. It appears that at least the mechanical factor of patency should be possible of determination in most cases. The method of inflating the uterus with carbon dioxide gas with the production of an artificial pneumoperitoneum obviates the necessity of surgical exploration and is especially serviceable in the obscure cases.

References

1. Rubin, I. C. The Non-Operative Determination of Patency of the Fallopian Tubes by Means of Intrauterine Inflation with Oxygen. *Jour. A. M. A.*, lxxv, 661–668, September 4, 1920. Subphrenic Pneumoperitoneum. *American Jour. Roentgenology*, viii, 120–128, March, 1921.
2. Kennedy, W. T. Isthmospasm of the Fallopian Tubes. *Jour. A. M. A.*, lxxxv, 13, July 4, 1925.
3. Meaker, S. R. *Boston Med. and Surg. Jour.*, cxc, 286–291, February 21, 1924.
4. Lee, F. C. Preliminary Note on the Physiology of the Uterine opening of the Fallopian Tube. *Proc. Soc. Exper. Biology and Med.*, 1925, xxii, 335–336.

5-a. Henderson, H. and Amos, T. G. *Jour. A. M. A.*, lxxviii, 1791, June 10, 1922.

5. Van Zwaluwenburg and Peterson. Pneumoperitoneum of the Pelvis. *American Jour. Roentgenology*, viii, 12–19, January, 1921.

6. Peterson, Reuben, and Cron, Roland. The Therapeutic Value of Transuterine Insufflation. *Jour. A. M. A.*, lxxxi, September 22, 1923.
7. Rongy, A. J. Primary Sterility. *New York Med. Jour. and Med. Record*, October 18, 1912.
8. Meaker, S. R. *Jour. A. M. A.*, lxxxii, 2098, June 28, 1924.
9. Cron, R. *Jour. Michigan State Med. Soc.*, xxiii, 61, February, 1924.
10. Cuthmann, H. *Monatschr. f. Geb. u. Gyn.*, lxiv, 55, September, 1923.
11. Charbonnet, P. H. *Journal Oklahoma State Med. Assn.*, xvii, 36, February, 1924.
12. Aldridge, A. H. *American Jour. Obst. & Gyn.*, vi, 53, July, 1923.
13. Hirst and Mayer. *American Jour. Obst. & Gyn.*, iv, 628, December, 1922.
14. Ottow. Zur Methodik der Tubendurchblasung. *Centralbl. f. Gyn.*, xlvii, 1752, November, 17, 1923.
15. Duncan, J. M. Fecundity, Fertility and Sterility, Edinburgh, 1866.
16. Giles, A. E. Sterility in Women, London, 1919.

PHYSICAL THERAPY TODAY*

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"PHYSIOTHERAPY" is a rather new term which was coined by the Office of the Surgeon General of the Army to describe what had theretofore been known amongst the profession as "physical therapeutics," and which is now also called "physical therapy." The American Medical Association recently recognized the importance of this field of therapeutics and created a Council on Physical Therapy to attempt its regulation, functioning somewhat in the manner of the Council on Pharmacy. Medical schools all over the country are becoming seriously interested in physical therapy and many are teaching it to both undergraduates and post-graduates, as Columbia University does today. I personally know of about fifteen hospitals which are now working on the problem of installing departments of physical therapy. I believe this is somewhat due to the position taken by the American College of Surgeons which has declared, so I have heard, that a truly modern hospital should have a department of physical therapy. I merely cite these instances to show that physical therapy has been gaining recognition ever since the time it proved its worth in the treatment of war casualties. Although it is not my idea to make a plea for the recognition of physical therapy, I do feel that when doctors all over the country realize how other men are using it, it will point out the way in which modern therapeutics is growing.

Many believe that to have any sort of understanding of physical therapy requires a deep study of electricity and physics. I do not think that this is necessary because it is easy to recall what we all studied in physics and physiological laboratories. Since it is not necessary that a man know exactly how to administer treatments in order to prescribe them, it does not require very deep painstaking study to acquire a grounding in the fundamentals. However, it *does* require a real course of post-graduate study to learn how to efficiently administer treatments and control a department of physical therapy. In a well organized institution, such as Beekman Street Hospital, New York, most of the staff have found out how to prescribe treatments, but their prescriptions are always subject to review by the Director or one of the Assistant Directors of the Department of Physical Therapy. We, who actually run the department, have to know all phases of the work and sometimes it is necessary to correct the prescriptions given so that the desired result can be more easily and thoroughly accomplished.

Perhaps it is surprising to hear the statement that you do not have to know all about the subject to rationally prescribe the treatments. Let me draw attention to the fact that by far the greatest part of physical therapy is medical common sense. An understanding of the pathology and of what reaction you desire to bring about in the patient can be called the common sense part. Three per cent of physical therapy is technical knowledge of whether the modalities can be applied effectively, conveniently and with safety to the part to be treated and how those modalities will work when brought into play. Two per cent of physical therapy is the actual knowledge of the technique so that you yourself can administer the treatments. Therefore, you can see that the common sense part of the subject is ninety-five per cent.

It always is proper in considering a subject to define it and the following may be suggested to explain what physical therapy is. It is the use of physical meas-

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ures in the treatment of any pathologic process in an attempt to convert an inadequate reaction on the part of the patient into one that is adequate. You may wonder how we expect to change this reaction, and that can best be answered by drawing attention to the fact that the basic action of practically all physical therapy, except ultraviolet rays, is either chemical, thermal or mechanical. I exclude ultraviolet rays from this classification because we cannot as yet prove why this form of light has such specific action upon the general metabolic functions of the body. Almost every week physicists find some new power in this invisible form of light, and it was only the other day that it was announced from Princeton University that one of their research fellows had been able to reproduce cold light in fish that had died, which while living were able to produce cold light themselves. This was explained by the oxidizing effect of ultraviolet rays.

I shall sketch briefly what modalities we use to accomplish the three effects that I mentioned above. The chemical effects that can be produced are attributed to a weak chemical action of the galvanic current. This current also has its well-established use in exercising muscles and in treating the nerves supplying muscles according to the effect wanted, due to its characteristic polarity action. This polarity action is an essential factor in the reactions induced by the galvanic current and it should be remembered that the polar reactions are diametrically opposite. For instance, the positive pole is sedative (positive for pain) while the negative is always irritative. When this current is made to alternate in a curve, which resembles the well known sine wave, it is called the sinusoidal current, which is used for the stimulation of paralyzed muscles. In that it reverses its polarity so regularly there are no chemical or polarity effects produced. The other current that is used for muscle stimulation is the faradic current, which is induced in a secondary coil by interrupting a galvanic current that passes through the primary coil. These three currents—galvanic, sinusoidal and faradic—have their own uses in the treatment of muscles to keep up their irritability and tone. The galvanic current energizes the muscle by going down the nerve; the sinusoidal by stimulating the muscle tissue itself and also going down the nerve, if that is under the electrode. The faradic current stimulates the motor end plate in the muscle, thus starting up the contractions.

The modalities used for thermal reaction upon different parts of the body are radiant light and high frequency electricity. Radiant light is obtained from an ordinary or frequently a high-candle powered incandescent bulb and it should be in a reflector that does not focus the rays of light. Focusing the rays of light brings in the element of the danger of burning the patient's skin. Radiant light has the capacity to penetrate to the depth of one and a half inches into living tissue. Governed by the old law of physics regarding the conservation of energy, you will remember that when energy in motion, such as light, is stopped, it becomes heat. We therefore have available a very convenient and simple method of forming heat within the tissues up to the depth of between one and one and a half inches. It has been proven that the heat underneath the skin is two degrees greater than the heat of the skin itself due to the reflection of some of the light and the ease with which this heat is dissipated into the surrounding air. One word of caution regarding light treatments. Recently I was asked to inspect the department of a large hospital in which light, in applicators containing from six to ten bulbs, was being used for the rational feature of heating a part before massage. It was found that patients were being burned with the applications of this light and the staff could not understand why this safe method of counterirritation was causing trouble. On investigation I found that it was the regular procedure to cover the entire applicator and the part

being treated with a heavy blanket in order to obtain better heat. This procedure caused a double dose of heat to be applied since there is the actual non-radiant heat of the hot glass of the bulbs and the metallic reflector surface behind them, as well as the radiant heat. The masseurs who were doing the work did not understand that the applicators were to be used to conduct light energy into the tissues and create heat therein. It is the correct procedure in such applications to always allow the air to circulate around the part to which light is being applied so that the non-radiant heat, which affects only the surface and is never able to penetrate beneath the true skin, can be quickly dissipated and the patient will receive the expected dose of radiant light.

There is a great difference, which most people do not appreciate, between radiant light and heat from a non-radiant source. Remembering that all forms of light below, in and above the visible spectrum, follow the same laws, and from heat wherever stopped, we must not think that the skin of the part must feel very hot at once when this form of energy is applied. There are really four sources of this light energy that we use to produce therapeutic effects. Infra-red rays, which are the longest, and as one might call them, "softest" rays, can be generated best by what are known as "blackbody" generators. These appliances do not even glow when working and only the light rays of the longest variety are emitted, which are too slow and long for the human eye to appreciate. The next form in the order of wave length are the ordinary copper reflector heaters with glowing elements in them which are not enclosed in glass. Such generators create light that is rich in the invisible infra-red and has some red and a little yellow in it.

The third form of light generator in use today is the incandescent bulb containing a *carbon* filament. The light from one of these bulbs in a non-focusing reflector contains much of the rays of the lower end of the spectrum but no infra-red because that is stopped by the glass itself. Infra-red is largely responsible for the bulb itself being so hot and the hot glass contributes non-radiant heat to the radiant heat that comes from the filament. When we use bulbs containing tungsten or "Mazda" filaments, light is generated that is poor in red and yellow components and we are able to make more light energy penetrate the skin in a long exposure, for the light from this source is not as hot to the skin and does not create a superficial hyperemia as quickly. Lights with this variety of filament are generally made of a blue colored glass which further helps to cut out the rays of the lower end of the spectrum. This form of bulb is frequently spoken of as a "daylight bulb" and salesmen who like to talk impressively, as most of them do, frequently call this glass cobalt glass. I heard of bulbs being made of this glass in Germany years ago, but it is easy to see that the ones in use today do not contain any cobalt. Cobalt in glass or in solution always makes the filament appear bright red when looked at because cobalt itself stops all red rays. I might mention that it was observed some time ago that when real cobalt glass is used light then produces an anemia rather than the usual hyperemia. These are the four methods of applying radiant light in therapeutics: infra-red in its invisible form from blackbody applicators; infra-red and red light from the copper reflector heaters in general use today; carbon filament incandescent bulbs; and tungsten filament bulbs.

It will be noticed that I have differentiated between radiant heat or light and non-radiant heat in speaking of light or phototherapy. There is a great difference in the effects of these two kinds of heat. As an example, let me draw attention to a common occurrence which probably has raised no scientific thought. When going along in a railroad train, if the window next to which you are sitting passes a steam engine, giving off non-radiant heat,

as we all know, you feel little if any heat. But if the train passes a pile of railroad ties that are being burned up, your attention is always attracted to the fire because you feel a slap of heat on your face. The heat of the engine boiler may be much greater than the fire of railroad ties, but the heat from the black painted iron, being non-radiant and not like light, is easily blown away by the air rushing along the sides of the engine. The radiant heat from the fire, traveling as light in straight lines, cannot be deflected by any force of the wind or air.

This fact may explain why light, when applied to a part or the whole body, should always be given through circulating air which keeps the non-radiant light from heating the skin and burning it but does not affect the dose of light being given that penetrates into the flesh and forms heat there.

I hope you will pardon my spending so much time in describing how light works in treatment, but as it is the simplest and safest way of producing counterirritation and is of such great use in so many conditions, the knowledge of phototherapy comes in very handy and is always available even at patients' homes. Let me only suggest that you try it in pleurisy, bronchitis or on painful joints.

I shall not go into the general indications of this kind of physical therapy or treatment with radiant light because, as I said, the ninety-five per cent holds good when you figure out whether or not inducing a hyperemia in the part will benefit the patient. Let me only admonish you regarding the technique of giving light. Never give it less than fifteen minutes and always allow for a slow formation of the superficial hyperemia with as little discomfort to the patient as possible. If the skin gets too hot, the mere passing of your hand over the surface will render it more comfortable for the patient.

The other thermal method we have is the use of high frequency electricity. It was demonstrated some thirty years ago that currents that alternate faster than 5000 times per second do not induce any reaction, either nervous or muscular, in living tissue. It was noted by d'Arsonval, who is still Professor of Medicine in the College of France, that heat was produced throughout the path of the current through the part, and it could be regulated to have its maximum intensity at whatever depth was desired. Nagelschmidt of Berlin a few years later named this heating through of the tissues "diathermy." Contrary to some opinions, the heat is not generated within and then comes to the surface, but is generated evenly throughout the tissues between both electrodes. I shall not go into a deep description of diathermy and its uses, because that deserves a paper by itself and would necessary involve the use of so many electrical terms that it would be uninteresting to the average listener. Suffice it to say that as we can always control electrical currents as delicately as we want to, so is it possible to control the effects of diathermy. We can create heat in any location of the body and have it as mild or severe as we want. The actual technique of applying diathermy is something that cannot be learned from books. There is always some danger accompanying the administration of high frequency electricity and technique in this branch of physical therapy is much more than two per cent. The bipolar high frequency current is known as the d'Arsonval current and is the one used for diathermy. There is another bipolar current called the Tesla current which is seldom used or in fact made by most machines. It is less confusing if one forgets this current as it has no advantages; but as far as voltage and amperage go, it bridges the gap between the d'Arsonval and the monopolar high frequency current called the Oudin. There is one peculiarity of high frequency electricity, however, that is worthy of mention, and that is in the use of the Oudin current which is delivered from a single terminal on the machine. This current

has the peculiar power of charging any condenser or body that is brought near it and consequently it is used to convey high frequency electricity to a patient with the use of a single electrode. Both these currents are used for treating medical, postoperative surgical and actual surgical conditions. The surgical use of the bipolar or d'Arsonval current was named electrocoagulation by Doyen in 1907, and the corresponding use of the monopolar or Oudin current was named electrodesiccation by Dr. William L. Clark of Philadelphia in 1910. There is also a surgical-like use of the Oudin current known as fulguration, but this procedure was originally brought out by deKeating-Hart to be used in stimulating sluggish granulation tissue. Fulguration is not in general use today. It differs from electro-desiccation in that a long spark is formed between the electrode in the operator's hand and the tissue. Electrodesiccation is best performed with the needle inserted into the tissue or in contact with it. Those who may be interested in this surgical use of high frequency can find no better authoritative paper on the subject than that published by Clark in the *Journal of the American Medical Association*, vol. 86, February 27, 1926.

The surgical use of high frequency electricity for the actual destruction of tissue is about the only procedure in the field of physical therapy that can be called curative. There are many ways of administering high frequency electricity but I am talking more of the ninety-five per cent of physical therapy than I am of the technical two per cent.

The third effect that can be produced by physical therapy is the mechanical. This can be produced by the well-known procedures of massage, by therapeutic exercise and also by static electricity. Static electricity is generated only by a machine that forms electricity by friction. The current is characterized by being of extremely high voltage and almost negligible amperage. If you will remember that electricity can be compared to water in a system of pipes, the voltage represents the pressure and the amperage the volume. Therefore static electricity may be compared to water under great pressure being squirted from a tube like a fountain pen filler. This is a homely comparison but it gives an understanding of why static electricity, which is a current of great pressure, has only a mechanical effect when administered to patients. Static currents, as with other mechanical means, when applied to the part should always be preceded by the application of radiant light so that the hyperemia induced will encourage the part to remove congestion therein when the static current is applied. Space will not permit my going into any extensive description of static electricity but I may say that the use of this current is gradually increasing in its recognition. Those of us who do extensive work in physical therapy would not think of trying to accomplish the result we desire without the use of this modality.

I have not mentioned any particular effects of hydrotherapy in my classification of the three primary effects of physical therapy. Hydrotherapy can be classified mostly under the heading of thermal effects because it is either the contrasting temperatures of the water, such as are used in the Scotch douche and in contrast baths to toughen amputation stumps, or it is used for the sedative effect of the warm water and the very mild massage of the air bubbles in whirlpool baths that are so effective in some cases. Whirlpool baths are especially useful in chronic infections of the extremities but do not have a good effect upon acute ones. The hyperesthesia which accompanies peripheral nerve injuries can be well treated by whirlpool baths.

Heliotherapy I have also kept out of the classification as it is not thermal in its primary use. This subject should be taken up with ultraviolet light because it is the ultraviolet rays of the sun that are the "active principle," as one might

call it. Therapy with ultraviolet light is probably making the greatest strides at present and we are finding out all the time what a general beneficial effect this form of invisible light has upon the living body. I need only bring to your attention the use of ultraviolet light in the treatment of rickets, secondary anemias, and add that it is worthy of trial where it is desired to increase calcium metabolism for the stimulation of union of fractures.

Ultraviolet light also has a very superficial but powerful germicidal and stimulating action and in superficial cellulitis it is especially useful. This is also true where we desire to stimulate all the tissue present, rather than obtain our germicidal effect by causing the death of tissue, as with some chemical germicides. Ultraviolet has many false claims made for it because of our lack of understanding how this invisible light, which can penetrate at most only two millimeters into the skin, can bring about its metabolic results. Many people today are using ultraviolet light for its tonic effects and to them let me give the advice that they always keep the dosage low enough so that the patient does not get a real sunburn after any treatment. This is the opinion of the greatest workers in this field, here and abroad.

It is regrettable that physical therapy had to be built upon empiricisms, but that was because the few men who were the pioneers in this work did not have the opportunity to submit their findings to the constructive criticism of unbiased observers. I am not criticising the observers but rather the technique of the pioneers, who found that such astounding "miracles of medicine" were sometimes accomplished, that they were swept off their feet in their over-enthusiasm.

Physical therapy is getting a better chance to be observed carefully and critically in hospitals these days, and it is to be hoped that the subject can be brought forward in such a way that the profession will understand that physical therapy is an added tool in the armamentarium of the modern physician and surgeon. Over-enthusiasts have always tried to hunt out the cure-alls amongst these procedures but most of us who have been trained in a modern way, view them with really more scepticism than the men who do not understand anything about them. It is easy for some people to explain the actions of some physiotherapeutic procedures in an off-hand way that partially convinces the ignorant hearer. But it takes some exceptionally good explaining to convince one who has a good insight into the subject.

A knowledge of electricity, wiring, turning on switches, etc., does not presuppose a knowledge of electrotherapy. These qualifications are enjoyed by all roentgenologists but I am sure that if you ask them what they know of electrotherapy, you will find few who profess to know, or care to know, much about the subject. It is difficult enough to keep abreast of the progress of roentgenology and medicine just as it is hard enough to keep up in the progress of physical therapy and medicine. Therefore it works better to let the roentgenologist do his work by himself, rather than to wish the running of a department of physical therapy on him. I know this idea is not agreed upon by most hospital medical boards, but I can tell you from my personal experience that I had to give up *x*-ray work in order to keep up medicine and physical therapy.

Let me state that physical therapy has passed the experimental stage and has graduated from the class where it has to prove its worth. When rationally directed by one who understands the technique and prescribed by those who understand the modus operandi, it can be counted upon to produce gratifying results when applied in the general therapeutics of many conditions; and it is surprising to see how the period of convalescence can be shortened by its use. In this brief consideration of the subject I hope I have done something to take away its mysteriousness and to reveal the honest simplicity of this adjunct in the field of therapeutics.

THE ETIOLOGY AND INCIDENCE OF THERMAL BURNS

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THE purpose of this communication is to consider the causes and occurrences of burns and scalds, to emphasize the neglect of certain precautionary measures, and to stimulate increased interest in the prophylaxis and reduction of the morbidity and mortality rate of burns.

"A burn is an injury inflicted on the body by a degree of heat higher than is compatible with healthy action in the part affected." The types of thermal trauma are two: burns that are produced by dry heat, and scalds by moist heat. The skin is the most common seat of caloric injuries, which are accordingly termed dermatitis calorica, of which there are two divisions, dermatitis ambustionis (burn) and dermatitis congelationis (frostbite).

The progress of civilization and the improvements in the arts and sciences have greatly multiplied the frequency and severity of burns. With the replacement of gas by electricity for illuminating purposes, the percentage of burns from gas has steadily diminished.

About 45% of deaths from burns occur from birth through the fifth year. The frequency of burns and scalds in children can often be attributed to the carelessness of parents and servants, and to the natural temerity and incautiousness of children. Severe and fatal scalds have been produced by placing children and infants in baths supposed to have been properly tempered. In the confusion, concomitant with a convulsion in infants, or by the hot bath treatment for asphyxia neonatorum, the overheated water has been responsible for serious loss of skin. Scalds frequently occur by small children falling into open tubs of hot water. Kettles containing boiling water, soup, or coffee, are only too frequently upset, spilling their contents on the upturned faces of little children.

Burns are more common and severe in instances where tactile sensations are subnormal or absent, as in tabes dorsalis, acute alcoholism, coma of various types, epilepsy and paralyses. The injudicious use of hot water bottles applied to the bodies of anesthetized individuals for the purpose of inducing a better circulation occasionally result in a burn, because pain, "the warning sentinel of injury" is lacking. A paralyzed limb is burned or scalded at comparatively low temperatures. Every surgeon has encountered burns of epileptics, and patient and doctor alike are happily surprised to note a disappearance or lessened frequency of the epileptic attacks. This peculiar phenomenon was known by physicians of an early date, who heroically and unsuccessfully attempted to cure epilepsy by burning the patient.

Burns kill more females than males. Statistics for a long period of years show that three out of five deaths from burns are of women and girls.[1] During the first three years of life, although they are similarly dressed, more boys than girls die of burns, probably because the venturesome spirit of the boy exposes him to greater danger. Figures of the Metropolitan Life Insurance Company covering a period of over twenty years show that in the fourth year of life the relatively high death rate of females begins. "The margin increases from five to nine years where more than twice as many girls as boys die of this cause, and there is a more or less pronounced excess in the death rate for females until the age of thirty-five is reached. It is not until the age of thirty-five is reached, where very large numbers of men are engaged in industries subjecting them to the hazard of burns and scalds

TABLE 1

DEATHS FROM BURNS (CONFLAGRATION EXCEPTED)

Area and Year	Per Cent of the Estimated Population of Continental U. S. in the Registration Area	Total	Males	Females	Rate per 100,000 Estimated Population (Both Sexes)	Age (Both Sexes)																	
						Under 1 Yr.	1 Yr.	2 Yrs.	3 Yrs.	4 Yrs.	5–9 Yrs.	10–19 Yrs.	20–29 Yrs.	30–39 Yrs.	40–49 Yrs.	50–59 Yrs.	60–69 Yrs.	70–79 Yrs.	80–89 Yrs.	90–99 Yrs.	100 Years and over	Deaths at Unknown Age
The Registration Area[1]																							
1922	85.3	5962	2456	3506	6.4	251	648	651	639	440	771	326	433	370	321	324	295	277	169	36	3	8
1921	82.2	5329	2242	3087	6.0	221	582	624	589	430	645	327	365	357	275	255	250	259	118	17	8	7
1920	82.2	6645	2718	3927	7.6	273	652	765	694	539	853	466	472	451	372	312	297	282	170	24	13	10
1919	81.1	6409	2688	3721	7.5	251	686	773	656	547	828	398	434	421	364	299	278	251	176	27	8	12
1918[2]	78.5	6638	2930	3708	8.2	239	688	748	710	482	809	411	480	462	406	334	335	302	171	20	6	14
1917[3]	73.4	6830	2976	3854	9.1	302	720	801	660	462	734	434	556	457	403	368	328	334	171	29	7	63
1916	70.8	5726	2579	3147	8.0	243	660	656	604	443	614	294	466	412	305	314	283	266	136	20	4	6
1915	67.5	4804	2105	2699	7.2	194	576	595	488	339	489	267	398	308	291	235	249	219	128	18	7	3
1914	67.2	5021	2192	2829	7.6	206	547	642	524	394	553	274	352	355	294	251	223	223	142	24	3	14
1913	65.5	4935	2156	2779	7.8	208	534	634	550	427	531	256	386	346	268	261	211	208	97	11	4	3
1912	63.5	4839	2072	2767	8.0	183	531	582	514	367	504	258	387	353	295	262	244	233	95	17	3	11
1911	63.2	4567	1891	2676	7.7	177	530	558	530	333	441	261	330	322	306	260	222	195	80	9	5	8
1910	58.3	4182	1810	2372	7.8	150	447	508	432	298	476	229	352	318	266	205	212	192	78	11	3	5

[1] Includes the D. C.

[2] Age details excludes 21 soldier deaths, data not available.

[3] Age detail excludes 1 soldier death, data not available.

that as many males die from this cause as do females. In later life when fewer men are subject to these risks, women again experience a much higher death rate. Burns of women occur at home and arise usually from their household duties. Female attire is an important factor in increasing the hazard."[1]

Burns are more common in winter than in summer. Burns stand fourth in numerical importance among the causes of accidental death, being outranked only by automobile fatalities, falls, and drownings. A study of Table One, showing the number of deaths from burns, by sex and age, for the U. S. registration area for the years 1910 to 1922, inclusive, will show the decline in the ratio of the number of deaths per 100,000 of population. The increasing number of yearly deaths can be partially attributed to the greater registration areas and the increase in population.

Table II

MORTALITY FROM BURNS AND CONFLAGRATION IN U. S. DEATH REGISTRATION AREA AND METROPOLITAN LIFE INSURANCE COMPANY. INDUSTRIAL DEPARTMENT

Year	Burns		Conflagration	
	Deaths	Death rate* per 100,000	Deaths	Death rate† per 100,000
U. S. Death Reg. Area				
1922	5,962	6.4	‡	‡
1921	5,329	6.0	928	1.0
1920	6,645	7.6	1,042	1.2
1919	6,409	7.5	977	1.1
Metropolitan L. I. Co. Industrial Dept.				
1923	910	6.3	‡	‡
1922	842	6.1	147	1.1
1921	892	6.6	79	.6
1920	1,061	8.1	121	.9
1919	1,001	8.1	104	.8

* Death rate per 100,000 population in U. S. Death Registration Area.

† Death rate per 100,000 policy holders in the Metropolitan L. I. Co., Industrial Department.

‡ Not available.

Unfortunately, statistics concerning burns include death by conflagration, although all the deaths that occur in connection with burning buildings are by no means due to actual burns, but are often to asphyxiation, crushing, etc.[2]

Of all persons sick and unable to work in the various industries from 0.5% to 0.9% are incapacitated on account of burns. An approximate mortality rate is hard to estimate, because so many burned patients are ambulatory, but of hospital admissions, from 25% to 30% of patients die as a result of their injuries. The number of yearly deaths from fire due to fireworks varies between twelve and forty individuals: these burns are produced by giant fire-cracker and powder explosions.[3] In the recent World War among the personnel of the U. S. Army, there were 6,148 cases of ordinary burns with 115 deaths, and 1,325 cases of chemical burns (exclusive of mustard gas) with 7 deaths.

Table III

DEATHS AND DEATH RATES PER 100,000 POPULATION FROM VARIOUS KINDS OF BURNS, U. S. REGISTRATION AREA, 1921[4]

	Deaths	Death Rate per 100,000 Population
Conflagration	928	1.0
Burns; (conflagration excepted)	5,329	6.0
(*a*); Molten metal	14	*
(*b*); Playing with fire, matches etc.	447	0.5
(*c*); Fall into fire	113	0.1
(*d*); Scalds	1,371	1.5
(*e*); Others	3,384	3.8

* Less than one-tenth of one per 100,000 population.

The frequency of fatalities from burns occurring in civil life is generally underestimated. A table is given to illustrate the relative death rates from burns and appendicitis; showing that burns are not given enough consideration by medical press and medical teacher. The decrease in the death rate of burns is not due to any radical betterment in therapeutic procedures, but rather to certain prophylactic

measures for which the medical profession has not been directly responsible.

TABLE IV

DEATH RATES PER 100,000 FOR BURNS AND APPENDICITIS. U. S. REGISTRATION AREA

Year	Death Rates per 100,000 U. S. Reg. Area	
	Burns	Appendicitis
1924	*	*
1923	6.7	14.8
1922	6.4	14.2
1921	6.0	14.4
1920	7.6	13.4
1919	7.5	11.8
1918	8.2	12.2
1917	9.1	12.6
1916	8.0	12.8
1915	7.2	12.5
1914	7.6	12.3
1913	7.8	12.1
1912	8.0	11.6
1911	7.7	11.7

* Not available.

A burn can be caused by any body that radiates much heat.[5] This is commonly due to proximity to, or direct contact with, flame or heated solid bodies, superheated air, gas explosions and inflammable liquids, such as benzine and turpentine. Scalds are produced by the action of boiling water, or other liquids, superheated steam and molten metals. The difference in the effects of burns and scalds is comparable to the distinction between roasting and boiling.

The results of burns vary according to: 1, the degree of temperature; 2, the nature of the exciting agent; and 3, its capacity for heat absorption; the duration of contact; 5, the susceptibility of the part acted upon; and 6, the condition of the patient.

Dry heat of 140° F. and upwards is capable of producing burns; scalds by moist heat of 125° F. and higher. The higher the temperature of the burning agent, the more severe injury will result, other conditions being equal.

Fluids, such as oil, that boil at higher temperature than water produce increasingly severe results. The thicker the fluid is, at the same temperature, the greater is therefore its capacity for heat. Moreover, this oleaginous fluid adheres longer, and evaporation being slower, the effect is naturally more severe. As the heat of solid bodies is usually greater than that attained by liquids, except metals in a state of fusion, the former may produce very deep burns; while liquids flowing over a large surface, cause more extensive though comparatively superficial lesions.

Solid substances as iron and steel, and the fixed oils (olive and linseed) cause more severe burns than aqueous materials. Fluids of the nature of alcohol and chloroform, produce only very superficial burns because of their volatility. The relative capacity of the substance for heat does not always determine the intensity of the injury, although in many instances this is true. For example, it is generally known that copper will occasion a more violent effect than iron, although the latter possesses a greater capacity for heat. This apparent paradox can be explained on the assumption that some articles are not only better heat conductors than others, but they cause a more decided destruction of tissue, due to their tenacious adherence to the surface. This factor is evident in burns by hot pitch. In such instances the adherence to the skin involves the tearing away of the superficial portions of the derma in the removal of the burning agent. The degree of inflammation is proportional to the length of contact of the burning agent, a short period favoring a mild injury and a long period even an incineration.

Dense and thick skin (palms, soles and buttocks) offer a greater resistance to heat than is offered by that of thinner, softer texture (neck, abdomen and axilla). All the tissues are not equally susceptible to heat destruction. The application of heat within the stomach at 65° C., within the colon at 68° C., and within the peritoneal cavity at 58° C. will cause vesication. The skin is more resistant than the

mucous membrane and the latter more than the peritoneum (Turck[6]).

All individuals are not equally susceptible or sensitive to heat. Thus, it is a common experience that one person can handle hot objects that would burn another; the difference here is not entirely related to thickness of integument, or sensitiveness of the nerve endings for heat. Duke[7] has presented evidence that patients may be allergically sensitive to heat from any source—hot water, hot weather, hot drinks, heat of lamp—and that these patients gave what he termed reflex-like reactions such as erythemia, pruritus, urticaria, and angioneurotic edema. Practically all of these patients had constantly a subnormal temperature. They would undoubtedly burn easier than the normal person.

Metals in a state of fusion produce lesions that are usually of a greater severity on account of the high temperature to which they have been raised.[8] Such burns are theoretically classed as scalds. But the lesions cannot be easily distinguished from burns caused by solid bodies. The catastrophe of carbonization has frequently occurred in metal foundries, where the workmen have accidentally placed their feet, or some other part of their bodies, in the course of the molten metal.

In explosions, the mechanical violence as well as the burning, must be taken into account. Gun-powder explosions usually produce severe and deep burns. A brush burn is a variety of contused wound, known also as a friction burn. The injury is a double one, caused by a wearing away of tissues, and by the heat generated by friction. It is produced in innumerable ways, as by a rapidly revolving grindstone, the friction of a rope slipping through the hands, an involuntary slide down a steep incline, contact with the rapidly revolving leather belts of machinery, etc.

Continued or prolonged exposure of the skin to artificial heat, produces an erythematous burn known as *erythema ab igne* (*ephelis ignealis*) or fire flowers. This appears as a mottling or marbled appearance of the skin, occurring for the most part on old people, who toast their legs at the fire. It is also frequently observed on the chin and cheeks of cooks, stokers, steel mill and blast furnace employees.

SUMMARY

1. Burns and scalds merit especial consideration because the great majority of these injuries are preventable.

2. The mortality rate of burns and scalds is exceedingly high, as compared with other injuries of equal frequency.

3. The therapeusis of these injuries in general use today has not appreciably bettered the prognostic outlook, if we judge from statistical records.

4. Because of the prevalence of burns and scalds in children of pre-school age, they should be particularly protected from the possibilities of thermal accidents.

5. In their conduct of household duties, women too frequently are oblivious of the dangers to which their clothing subjects them.

I wish to express my thanks to Dr. Louis I. Dublin of the Metropolitan Life Insurance Company, and to Dr. William H. Davis of the Department of Commerce for the statistical data.

References

1. Statistical Bulletin; Metropolitan Life Insurance Company, October, 1923.
2. Dublin, Louis I. Personal communication to the author.
3. Fourth of July Injuries. *J. A. M. A.*, lvii, 736, August 26, 1911.
4. Mortality Statistics. Department of Commerce, Bureau of the Census, 1921, Bulletin 152.
5. Shuh. *Allg. Med. Zeitung*, 1864.
6. Turck, F. B. Am. Jour. Surg., xxxvii, 129.
7. Duke, W. W. Physical Allergy, *J. A. M. A.*, lxxxiv, 736, March 7, 1925.
9. Pouillet. Comptes Rendus, 1836, p. 782.

THE SNARE IN ABDOMINAL SURGERY

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EXCEPT in the hands of certain specialists the snare is rarely, if ever, employed. Certainly general surgeons scarcely ever use this ancient and very helpful instrument.

A rapid survey of the abdominal field will readily disclose a number of situations in which the snare can be profitably used. Its small size, its ease of handling, its firm grip of the tissues and the readiness with which that grip can be released, all commend it highly.

In pylorectomy the handling of the duodenal stump is of the utmost importance. Except in the Billroth 1 method, this stump must be crushed and carefully inverted to prevent leakage. Here the snare is ideal in safety, convenience and speed. The lumen of the gut can be closed by ligature, suture, or a combination of the two. The wire of the snare is loosened only after the inversion is completed and the sutures nearly drawn tight.

For temporary control of hemorrhage in large pedicles, masses of omentum, etc., the snare can be used with safety and speed. After the removal of tumor, cyst, or omental mass, one can clamp and ligate the exposed vessels separately at his leisure, or pass a mass ligature or suture. No time is lost and the exposure is far better than that obtained by the use of heavy crushing clamps.

In resections of the bowel, especially the large bowel, the snare is readily adaptable to the so-called aseptic methods of resection and suture. The end-to-end, end-to-side, or lateral anastomosis can be quickly and safely performed with a minimal chance for leakage.

The great advantage of the snare is easily demonstrated, in that the wire can be loosened and withdrawn after the inversion stitch is completely placed and nearly drawn tight. In end-to-end anastomosis the primary and secondary sutures can nearly all be placed and tied before the snares are released and withdrawn. The opportunity for contamination is almost nil.

Occasionally nephrectomy is a most difficult operation because of inability to expose the pedicle and safely apply clamps. In such cases the wire of a snare can often be laid in place and easily set home. The same is true in high amputations of the rectum. The added inch of bowel that can be safely removed in this way may prove the deciding factor for ultimate cure. A further advantage is that, if needed, the snare may be left in situ until its work is done.

This plea is merely for the revival and extended use of a time-honored instrument. Needless to say, good workmanship and materials, especially as regards the quality of the wire, are essential, as is a moderate degree of skill in its use.

TOO TIGHT ABDOMINAL BANDAGING

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GRAND FORKS, N. D.

ACUTE spastic contractions of the muscular fibers of the intestinal tract following operation under ether are dreaded by both patient and surgeon. They are a source of much suffering to the former and of worry and anxiety to the latter. They are occasionally the first signs of a serious process in the field of the operation.

During the late 80's and on to the first decade of the 19th century a large number of patients suffered more acutely and longer after operation than at the present time. This was due, in great measure, to excessive and unwarranted catharsis for from one to three days preliminary to the operation.

The suffering after laparatomies can be much reduced by the simple procedure of applying lightly fitting dressings. During the last decade I have invariably ordered my assistants and nurses to apply the abdominal bandage with the idea only of keeping the wound from being infected and not to support the freshly united celiotomy incision. It has been my experience that these instructions are seldom followed out and on one of my first visits I find the patient in distress and sometimes in agony due to too tight bandaging.

I have had scores of cases where the relief from gas pains has been almost miraculous following the cutting of the bandages, where only a cursory examination would have revealed no constriction or pressure whatsoever. In many cases the mere weight of excessive dressing material seemed to have been the causative factor of these reflex contractions of the intestinal muscularis. I have seen numerous cases where moderate doses of morphine with atropine supplemented by repeated doses of pituitrin have afforded only temporary relief, when by simply loosening the bandaging instant relief was afforded. In the past decades women were more immune to these distressing complications than men, due in the main, to the habit of wearing tight-fitting corsets; but this immunity, especially in younger women, is now nonexistant.

According to Metzinger the blood supply of an organ often determines its sensitiveness to pain; the organs richest in blood supply suffering the greatest pain. This is in accordance with the theory of Oppenheimer who claims that pain is created and carried by the vasomotor fibers.

External irritation or pressure causes irritation in the nerve terminals of the sensitive parietal peritoneum as well as the traumatized viscera, and these irritations are transmitted as intense pain throughout the sensory and vasomotor nerves to the splanchnic system and, being reflexed, they in turn increase the rigidity of the abdominal muscles with still further increase in the pain and spastic contractions of the muscularis of the intestinal tract. Thus there is produced an abdominal crisis with dilatation of the bowel above the constricted fibers.

Only in exceptional cases is a surgeon justified in supplementing his closure technique by external support and, therefore, any dressing or bandaging beyond the mere necessity of keeping the wound sterile is uncalled for and at times wrought with pain and even danger. Gas pains are, in a large number of cases, simply bandage pains.

TRACTION WEIGHT DEVICE

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SHORTLY after the war, when in need of traction weight for use in the treatment of fractures, I encountered difficulty in securing the standard traction bar with cast iron weights. Shot was too expensive at that time to invest in many pounds for the purpose in view. I found at a general hardware store what is known in the trade as an inch-and-a-half iron washer. This seemed to be a convenient shape and weight. It was a piece of metal, round, 3½ inches in diameter, with a hole in the center 1½ inches in diameter. It weighs about one-half pound varying according to the thickness of the metal from which it is stamped. The cost in bulk is about six cents a pound, but varies slightly with the iron market. At first I used this washer by stringing it on a rope and making use of what sailors call a toggle to hold it on the rope. The toggle can be readily threaded through the eye of the washers and then placed crosswise to hold them on the rope, as shown in Fig. 1.

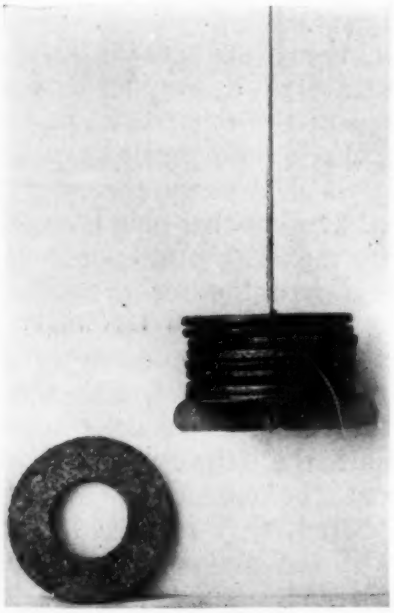

FIG. 1. Washers used as weights, on a toggle.

The disadvantage of this is that in order to change the weights, either to remove one or to add others, the whole string of weights must be moved upward so that the toggle can be freed. This is apt to cause pain to the patient when done carelessly, although, when done carefully, it causes no discomfort.

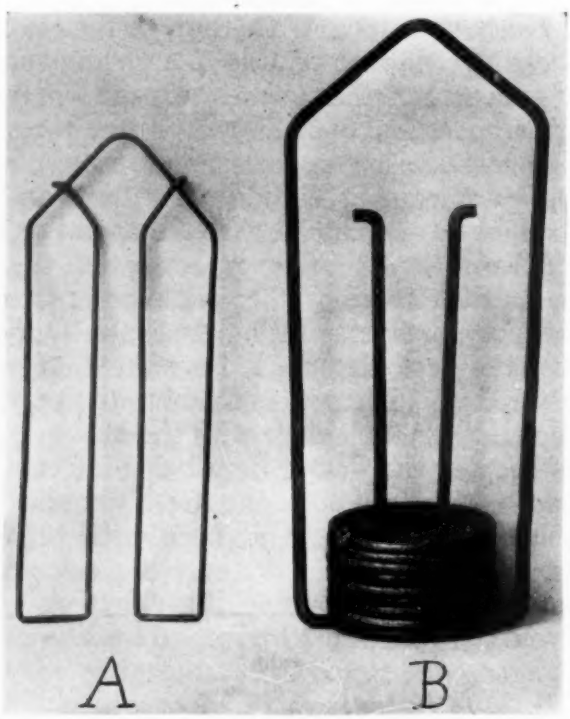

FIG. 2. A. Telegraph wire bent in the shape of last design, ready for washers. B. Washers on square bar iron bent in shape of original design.

To obviate any possibility of causing pain to the patient or of releasing the traction weight for an instant, I devised a wire holder. The first ones I made of 3/16" to ¼" tinned iron wire bent in the shape shown at B, Fig. 2. I was quite satisfied with this until I found that if made in lengths of 18 to 24 inches of this material, when there were a great many washers on the column of weights would tend to fall sideways, and this would produce a twist of the lower horizontal pieces of the holder,

connecting the side bars with the center pieces. In the shorter weight holders this did not take place. To obviate this I made weight holders out of ¼" square bar iron, as shown at B, Fig. 2. This material is excellent for this purpose and easily workable. It does not twist at the points before mentioned as easily as the round material. To obviate the weak features in the first model, and to enable anyone for whom it is not possible to secure square bar iron to make a safe holder, I made the model A shown in the illustration. I extended the central holding arms upward, then bent them outward until they crossed the two upper arms. The ends of the central members are bent in the shape of a half circle hook, which grasps the members they rest against loosely, so that they can be hooked and unhooked at will.

To make these holders a pattern is laid out full size on paper for holders of different lengths for different total weights. Measurements of these are laid off on a piece of such metal as is available. The upper center bend is made first. A mechanic's trick, which facilitates form and speed, is to use a piece of gas pipe just large enough to slide over the wire or square bar iron used for the holder. The bar is held in the vice with the center mark at one side of its jaw, the pipe is thrust over the rod up to the mark, and used as a wrench to bend the bar to the desired angle. The tools required are: vise, piece of gas pipe, monkey wrench, hammer, hack-saw and file.

Washers to the desired weight are put on the holder in model B by springing the center arms together and slipping them through the opening in the washers. In model A the same procedure is required except that the upper ends must be unhooked first and then hooked after the washers are in place. The hooks in the later model grasp the more tightly, the more the weight on the upright. When these models are made properly, they can be turned upside down without the washers slipping off.

To change weights it is not necessary to let up on the traction, but sufficient weight can be added or taken off, by even the most careless, without causing pain.

The washers weighing approximately one-half pound, it can be readily seen how the total traction weight can be readily estimated, by determining the numbers of washers on a holder. This also facilitates balancing adjustments in the use of the Thomas splint.

When the holders and washers are given a coat of aluminum paint, they present a neat appearance.

The washers are readily procurable at any good sized hardware store. The square bar iron is rather more difficult to secure, but the heavy round telegraph wire is easily procurable.

The apparatus can be made by convalescent patients as a form of occupational therapy. I personally believe it is the cheapest form of weight other than bricks or sand. The washers can be made use of in bags in the manner in which shot bags are used, but I personally prefer one of these devices secured by a spring snap hook to the traction rope, when weights are suspended over a patient, to avoid the possibility of their falling upon him.

HYDROCELE MULIEBRIS

REPORT OF A CASE

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THE literature concerning hydrocele muliebris, i. e., cyst or hydrocele of the canal of Nuck, is exceedingly meager. The index to *Annals of Surgery*, 1855 to 1924, inclusive, fails to disclose a single reference to Nuck's canal. The index to the *British Journal of Surgery*, 1913 to 1923, inclusive, contains no reference to the subject. The *Cumulative Index* to current medical literature, published by the American Medical Association, January 1, 1916, to December 31, 1925, lists but two contributions concerning this topic, one by W. R. Smith and one by R. Andler. Further investigation reveals only six other indexed references since 1908, all of which are in foreign periodicals inaccessible to me. As a matter of information, however, a list of these is appended.

It is obvious from the foregoing that hydrocele muliebris, cyst or hydrocele of the canal of Nuck, is sufficiently rare to justify the report of a single case. The subjoined anatomic data, abstracted from various sources, are interpolated to show the present state of knowledge on this subject.

Nuck's canal: The canal formed by Nuck's diverticulum, which is a pouch of peritoneum covering the round ligament of the uterus and extending into the inguinal canal of the young female (Cattell).

In the female fetus a pouch (canal of Nuck) of peritoneum accompanies the round ligament of the uterus a short distance into the inguinal canal. A small depression or pocket, usually to be seen in the adult in the position of the internal abdominal ring, is the remains of this pouch. It sometimes becomes the commencement of a hernial sac (Leidy).

The round ligaments of the uterus are two rounded cords, four or five inches long, commencing at the superior angles of the uterus and passing forward and outward through the internal abdominal ring into the inguinal canal to finally become lost, after dividing into three fasiculi, in the fatty tissues of the mons veneris. They consist of dense fibrous tissue and unstriped muscle, enclosed, in the fetal state, by a process of peritoneum extending a short distance into the inguinal canal, the so-called "canal of Nuck," which is usually obliterated in the adult, but is sometimes pervious throughout life (Nancrede).

Cystic dilatations of constricted portions of the canal of Nuck sometimes occur. They may present in the labia majora as large cysts lined with endothelium derived from the peritoneum (Warthin).

Hydrocele of the round ligament: Small cysts, containing serum, are sometimes found within the peritoneal investment that ensheathes the round ligament for a varying distance within the inguinal canal. They present as ovoid, tense sacs within the inguinal canal or at its external orifice. They are to be distinguished from hernia, from glandular enlargements, and from lymphatic dilatations. They may be extirpated with the knife if they are the cause of any discomfort. If they communicate with the general peritoneal cavity, they are practically hernial sacs, and require the same treatment that would be suitable for the latter condition (Keen-White).

Hydrocele of the canal of Nuck may be present, forming a cystic tumor in relation with the round ligament. A true cystic myoma may develop in the parenchyma of the round ligament. Clinically, these tumors are found in the inguinal canal, beneath Poupart's ligament, or in one of the labia majora. Treatment consists of

extirpation of the sac and direct suture (Beyea).

Case Report

D. C., negress, aged 38, was admitted to the Louisville City Hospital, June 6, 1925, on account of a tumor of the uterus and a painful enlargement of the left labium majus.

Abstract of History: The patient had one normal delivery sixteen years ago and since then two miscarriages. Her menses have been regular. The duration of each period during the last few years has been ten days to two weeks. She first noticed the presence of a painless abdominal mass four years ago. One year ago she observed a swelling of the left labium majus which was at first present when standing and disappeared when recumbent. For the last four months this swelling has been constantly painful. She states that greater pain is noted when she assumes the recumbent posture.

Examination was negative except for the large uterine tumor, readily diagnosed as a myofibroma, and the enlargement of the left labium majus to about the size of a half orange. The mass fluctuated, could not be reduced by manipulation, and coughing transmitted to it no impulse. The swelling extended along the course of the round ligament. The patient complained of slight pain on palpation.

Operation: Right rectus incision four inches long above the pubis. A multinodular uterine myofibroma, free of adhesions, was removed by subtotal hysterectomy.

Surrounding the left round ligament, beneath the peritoneum and extending into the canal of Nuck to the left labium majus, was a cyst of the size already mentioned. The peritoneum was incised over the left round ligament and blunt dissection disclosed the cyst wall immediately beneath the peritoneum, surrounding the round ligament, and extending through the canal of Nuck to the labium. The cyst wall was so fragile that it ruptured during the attempt to dissect it free. The wall was composed of very thin, translucent material similar to peritoneal bands. The content of the cyst was clear straw-colored fluid. As much of the sac was removed as possible and the peritoneal opening was sutured. Abdomen closed without drainage. Uninterrupted recovery.

In the case reported by Smith (1924) the patient was also a negress of 41 who was admitted to hospital clinic April 7, 1923, with the diagnosis of strangulated left inguinal hernia. Physical examination negative except for the presence of a tense, slightly tender, non-reducible mass in the left inguinal region measuring two by three-and-a-half inches in its greatest diameters. The patient stated that years previously she first noticed a "knot" in that situation which had gradually increased in size. The diagnosis was easily made of hydrocele of the canal of Nuck. The sac was dissected free and excised. There was no complicating hernia.

It will be noted that in Smith's case the hydrocele occurred on the left side the same as in the one herein reported. There is no known embryologic or anatomic reason why the left side should be affected oftener than the right as the relations are identical upon both sides.

There is little to be said concerning the etiology of hydrocele muliebris. The condition is due to failure on the part of nature to close the canal of Nuck during the process of development. Why nature fails to obliterate this canal in one instance and not in thousands of others remains unknown. The most that can be said is that hydrocele muliebris is the result of a developmental error.

According to Smith quite a variety of cystic enlargements in the inguinal region of the female have been described under names such as: hydrocele of the round ligament, hydrocele muliebris, pudendal hydrocele, labial hydrocele, hydrocele of the canal of Nuck, etc. Regnoli (as quoted by Smith) has simplified the classification as follows:

(1) Diffuse hydrocele in the connective tissue surrounding the round ligament;
(2) Hydrocele of the canal of Nuck communicating with the abdominal cavity;
(3) Encysted hydrocele of the canal of Nuck (no abdominal communication);

(4) Encysted hydrocele of the connective tissue enveloping the round ligament.

The symptoms of hydrocele muliebris are seldom of sufficent gravity to attract the attention of the patient, or cause her to seek medical advice, during the early stages of its development. Pain and tenderness do not become manifest until the tumor reaches such proportions as to cause pressure upon adjacent structures. This is true whether the hydrocele occupies the inguinal canal or the labium majus. Usually some intercurrent affection induces the patient to consult a physician, and the inguinal or labial abnormality is discovered at that time.

In uncomplicated cases of hydrocele muliebris there should be no difficulty in diagnosis. When the enlargement is confined to the inguinal region, however, it may be mistaken for hernia. It must not be forgotten that hydrocele muliebris and inguinal hernia may coexist, in which event there may be additional diagnostic confusion. Glandular enlargements and lymphatic dilatations in the pudendal and inguinal regions can be readily differentiated from hydrocele muliebris by painstaking investigation. "The diagnosis rests upon the presence of the slowly increasing tumor in this region, which is globular in form, symmetric in outline, non-reducible, elastic, and possibly fluctuant, usually not very tender, and which transilluminates. The diagnosis can be corroborated by aspiration, which gives a clear, straw-colored fluid" (Smith).

The treatment of hydrocele muliebris is essentially surgical. The sac should be freed from its attachments and excised.

The minor procedure of aspirating the contents of the cyst and the injection of irritating solutions (iodine, etc.) hoping to cause obliteration by the formation of plastic exudate is distinctly unsurgical and is attended by greater danger of infection, with subsequent sloughing of tissue, than the open method. As a matter of fact, I do not even approve of confirming the diagnosis by aspiration. This might produce serious infection if a complicating hernia were present.

References

Andler. *Zentralbl. f. Chir.*, lii, p. 1171, May 30, 1925.
Smith. *J. Med. Assn. Georgia*, xiii, p. 23, January, 1924.
Leidy. Human Anatomy, J. B. Lippincott Co.
Cattell. Lippincott's Medical Dictionary.
Nancrede. Essentials of Anatomy, W. B. Saunders Co.
Beyea. Ref. Handbook of the Med. Sci., Wm. Wood & Co.
Warthin. *Ibid.*
Keen-White. American Textbook of Surg., W. B. Saunders Co.
Regnoli. Cited by Smith, l. c.

Other contributions since 1908

Masters. Double Idiopathic Vaginal Hydrocele. *Jour. Tropical Med.*, xxii, 223.
Vanverts. One Case of Hydrocele Inguino-superficialis of the Canal of Nuck. *Ecbo Mèd. du Nord*, xvii, 1913.
Vanverts. Second Case of Hydrocele Inguino-superficialis of the Canal of Nuck. *Ecbo Mèd. du Nord*, xviii, 474.
Borsuk. Hydrocele in Women—Hydrocele Muliebris. *Medydyna i. kron. lek.*, Warszawa, xlvi, 1911.
Filotico. One Case of Hydrocele Muliebris Incurabili. *Napoli*, xxv, 385, 1910.
Hydrocele in Women. *Kbirngina, Mosk.*, xxviii, 1910.

TRAUMATIC DIAPHRAGMATIC HERNIA WITH INTERMITTENT HIGH INTESTINAL OBSTRUCTION

A CASE REPORT

HERMAN B. PHILIPS, M.D.

NEW YORK

ON February 3, 1921, when this patient was eleven years of age, he was run over by a heavy touring car, the front part of the car striking him in the right hip region and throwing him face downwards on the pavement. Two wheels passed over the lower part of his chest. He was taken unconscious to a nearby hospital, where he remained for days in a precarious condition. He was then removed to another hospital, where he remained for three weeks, recovering gradually without operation. A plaster cast was put on his pelvis. On arriving home, he developed severe pains and cramps in the left chest and left upper quadrant of the abdomen, with severe vomiting, extreme weakness, marked pallor and prostration. He recovered very gradually from this attack in three days, but remained weak and thoroughly prostrated for a week after. He had attacks of this character thereafter, accompanied by weakness, severe vomiting, cramps, marked pallor and threatened syncope. These attacks came on at night and lasted a day or two. Hot water bags afforded slight relief. The attacks became somewhat less frequent but occurred at least once a month. In addition to these attacks, which indicated intermittent upper intestinal obstruction, he suffered from dyspnea upon every slight exertion. To walk up one flight of stairs caused very rapid breathing and great palpitation. He did not gain any weight after the injury; and is decidedly undernourished and underweight, notwithstanding special dieting and vacations.

In April, 1923, he was referred to me for *x*-ray examination of his chest, chronic traumatic pleurisy being suspected. The roentgenological examination showed: An opaque shadow of varying density occupying the lower and outer two-thirds of the left chest, and confluent with that of the left diaphragmatic arch; the central portion of the shadow of decreased density, giving the appearance of sacculated air; the heart and mediastinum displaced slightly to the right side; marked compensatory emphysema throughout the upper third of the left chest and throughout the right lung area. (Fig. 1.) Diaphragmatic hernia was suspected and an opaque meal was given.

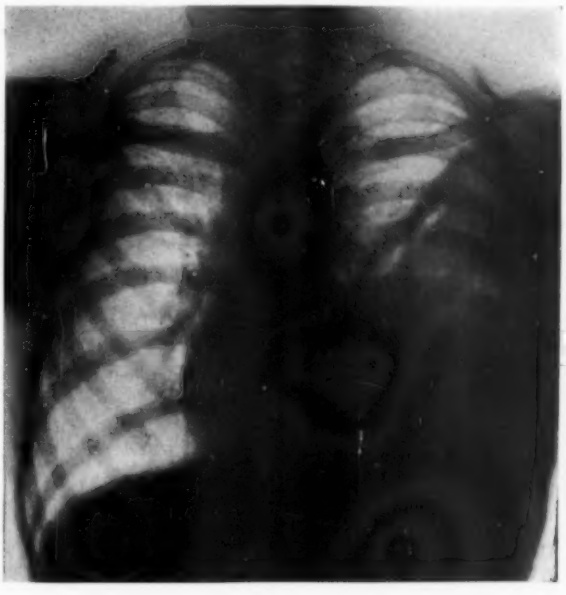

FIG. 1.

Then examined in the upright position, the stomach, except for the extreme pyloric end, was found to be entirely within the left pleural sac, with duodenum pulled upwards and inverted, the sphincter being above. The size of the rent in the diaphragm was suggested by the contraction of the pyloric end of the stomach (Fig. 2.)

Examination in the horizontal position showed the entire stomach pulled into the thorax. The duodenum could not be filled up in this position and it was apparent that while the patient is recumbent the obstruction of the pylorus is more complete and the contents of the hernia are obviously increased to a maximum. It could also be noted in the roentgenograms that in the horizontal position the heart and mediastinum are displaced more than when the patient is erect." (Fig. 3.)

Fig. 2.

Fig. 3.

April 1, 1924: The boy is still thin and undernourished. A restricted diet and the use of mineral oil keep him comparatively comfortable. The attacks now occur once in three months and are not as severe as previously. Roentgenological examination shows the hernia smaller, with less of the stomach in it. October 31, 1925: The boy's general condition is considerably improved, although he is still slightly undernourished and anemic. Dyspnea still develops on extreme exertion with severe pain in the pit of the stomach. He no longer has dyspnea or distress when recumbent. He has, however, considerable difficulty in falling asleep, because of discomfort in his chest. Roentgenological examination shows no change since the examination in April, 1924.

Comments: It is interesting to note the gradual readjustment of the gastro-intestinal contents in the left thorax, so that, aided by dietetic regulation, the attacks of intermittent upper intestinal obstruction have disappeared for over a year and a half. It is almost unbelievable that a traumatic displacement of the stomach into the chest, so easily recognized by roentgenographic examination, should have been overlooked for two years.

PERFORATED DUODENAL ULCER WITH STRANGULATED INGUINAL HERNIA

REPORT OF A CASE*

JOHN E. SUTTON, JR., M.D.

NEW YORK

ON November 25, 1925 a man, aged 50, was admitted to the Second Surgical Division of Bellevue Hospital complaining of severe, stabbing, upper abdominal pain. Two days previously a right inguinal hernia descended and became irreducible. A short time later he felt nauseated and vomited once or twice. Slight nausea continued for two days; he had recurrent cramp-like pain in the region of the umbilicus; and he passed no feces or flatus. At eight o'clock in the evening of admission the character of his pain suddenly changed to a sharp stabbing in the epigastrium. This was localized in the mid-epigastrium. His nausea increased but he did not vomit.

During the previous two years the patient had had a recurring, dull, gnawing, epigastric pain, one to two hours after meals, and a similar pain which awakened him between one and two o'clock in the morning. Taking food, sodium bicarbonate, milk or soda crackers had always relieved this pain up to one week before the onset of his present illness. At that time his epigastric pain increased in severity and duration and was not as completely relieved by his customary measures. For two or three years he had known of the existence of a right inguinal hernia. This had always been soft and easily reducible. Aside from slight discomfort there had been no symptoms referable to the hernia and no truss had been worn. His bowels had always been fairly regular. Cardio-respiratory, genito-urinary, and surgical history was negative.

He was acutely ill, lying rigid in bed. His respirations were of a rapid, shallow, costal type and the abdomen was held almost immobile. His tongue was clean and moist. Further examination of his head, neck, and thorax showed no abnormalities. There was no obliteration of the liver dullness. His abdomen, of the slightly scaphoid type, was held with board-like rigidity above the umbilicus. Pressure in the epigastrium produced acute pain, which was localized just to the right of the mid-epigastrium. In the right inguinal region there was a tense, irreducible, tender, globular mass about 6 c.m. by 5 c.m. in the region of the external inguinal ring. Rectal examination, negative. A leucocyte count showed 23,500 cells per c.mm. with 95% polynuclear cells and 5% lymphocytes. His temperature was 99° F. and his pulse was 66, regular and of good quality and volume. A pre-operative diagnosis of strangulated inguinal hernia with a possible perforation of a duodenal ulcer was made.

The operation was performed five hours after the onset of his acute upper abdominal pain. Under nitrous oxide, oxygen and ether anesthesia the hernia sac was exposed and isolated through a six inch right Bassini incision. The properitoneal tissue was intensely edematous and this edema extended upward and surrounded the neck of the sac. On incising the apex of the sac a large amount of gas escaped with an audible whistle. This was followed by gush of thick whitish green fluid. A loop of terminal ileum, which had been strangulated, showed many ecchymotic spots in its entire circumference but the serosa was intact and the mesenteric vessels pulsated normally. The neck of the hernial sac was closed by a purse-string suture of chromicized catgut and

* From the Second (Cornell) Surgical Division of Bellevue Hospital, service of Dr. Harold E. Santee.

no further attempt was made to repair the abdominal wall. The skin was loosely closed with silkworm-gut sutures.

Through a four-inch upper right rectus-splitting incision the stomach and the first portion of the duodenum were easily exposed. On the anterior-superior surface of the duodenum, 1 c.m. distal to the pyloric vein, was a punched out perforation, 1 mm. in diameter, surrounded by an indurated area, 1.5 c.m. in diameter. The perforation was closed with a purse-string suture of No. 00 chromicized catgut which was reinforced by a transverse suture of the same material. A tab of omentum was sutured over the line of the closed perforation. After closing the perforation it was easy to pass the tip of the index finger through the pyloric ring. As much fluid as possible was removed by suction and a cigarette drain was placed down to Morrison's pouch. The wound was closed about this drain with No. 2 chromicized catgut for the peritoneum and fascia and silkworm-gut for the skin.

Convalescence was uninterrupted. There were no complications aside from the development of a moderate sized hematoma in the partly repaired hernia wound. This was evacuated on the second postoperative day, and the wound was laid wide open. Cultures from the peritoneal fluid and from the inguinal hematoma showed abundant growths of staphylococcus aureus. The patient was allowed out of bed on the 24th postoperative day and home on the 29th postoperative day. His inguinal wound at this time was a shallow narrow granulating area.

On February 7, 1926 a follow-up examination showed the upper abdominal wound firmly healed. In the right inguinal region there was a slight bulge in the upper portion of the scar and a distinct impulse could be felt. Since leaving the hospital there had been no signs of indigestion, gaseous ructations or distention. He has had no pain. He has been carefully following a diet consisting of milk, eggs, cereals and mashed vegetables. The patient has returned to work as a baggage router. In six months he will be readmitted to the hospital for a repair of his right inguinal canal.

Appreciation of the privilege of reporting this case is expressed to Dr. Harold E. Santee.

TRANSACTIONS OF THE SECTION OF SURGERY, NEW YORK ACADEMY OF MEDICINE

MEETING OF MARCH 18, 1926

THE CHAIRMAN, DR. FREDERIC W. BANCROFT, PRESIDING

SYMPOSIUM ON FRACTURES

FRACTURES IN THE AGED

WILLIAM DARRACH, M.D., F.A.C.S.

NEW YORK

[From the Surgical Department of the College of Physicians and Surgeons]

IN the treatment of fractures in the aged, more than in any other age group, the necessity must be borne in mind of treating the patient primarily and his fracture secondarily. His future, both immediate and distant, will depend more on the careful and wise handling of his general condition than on the details of care of the local injury.

First let me emphasize a few general considerations:

After we pass the fifty-fifth year fractures become more common than in earlier years. In the different half decades above fifty-five the incidence is about the same. The bones become more brittle. *X*-ray examination will show a lighter shadow and a thinner cortical layer. The muscular system also shares in the blame for this higher incidence. The muscles are weakened and flabbier and so less fitted to assume their share in resisting the strain of trauma. Because of defective vision, a slowing up of reaction time, imperfect sense of balance, these patients are more liable to fall and less able to get out of the way of approaching forces. These factors are partially offset by the fact that usually the daily routine of life is less strenuous and dangerous.

Perhaps because of the lessened resistance to trauma on the part of the muscular systems, the amount of coincident injury to the soft parts tends to be less in the aged than in younger patients. Usually we do not see as much laceration of muscle, although the extent and duration of the ecchymosis, the external evidence of deep hemorrhage, is apt to be greater. The greater amount is associated with the brittleness of the blood vessels; and the less active circulation and powers of absorption explain the greater duration of this sign.

The edematous swelling, which rapidly succeeds the primary swelling of hemorrhage and displacement of fragments, is not as marked in the aged but it lasts longer and is harder to disperse.

It is usually easier to reduce the displacement of fragments in the aged than it is similar injuries in more powerful and active individuals as there is less muscular spasm and pull on the fragments. The problem of reduction, however, is more often complicated by comminution. The changes in the adjacent joints and muscles that follow fractures occur more quickly in the aged, are more marked and are harder to prevent or overcome. This must be remembered and should influence our treatment. Older people's joints are none too good even when they are not the seat of definite arthritides and their motive apparatus is weak and tremulous at best. Disuse rapidly encroaches on this limited margin of safety and they can ill afford such encroachment.

In the aged, the most dreaded complication of fractures, especially of the lower

extremity, is a hypostatic pulmonary lesion. This occurs less frequently with the modern methods, but measures to prevent it must always be carried out. Another similar condition is the mental change which we only too frequently see when our patient quietly but steadily becomes more and more drowsy, sleepy, comatose until he can no longer be awakened.

Repair of the bone is less rapid and less complete and faulty union is a little more frequently encountered in the aged.

There are but few fields of surgery where the double-edged character of therapeutic measures is more evident or its realization is more important than in fractures, and especially is this true in fractures in the aged. Each detail of treatment is potentially harmful as well as beneficial. Success in handling fractures depends largely on how conscientiously this is borne in mind and how wisely we minimize the evil results in making use of the helpful possibilities.

Local rest, whether partial, intermittent or complete, which is indicated in every fracture, must be made use of only as completely or for such a period of time as may be necessary. Otherwise the impairment of function from joint and muscle involvement due to disuse will become distressingly great and very difficult to overcome. Partial or intermittent immobilization can often be used when complete rest is indicated in similar cases in younger patients.

General rest in bed, when indicated, must be sparingly used. Too much bed is bad for old people under any conditions.

Anesthetics are indicated less frequently in the aged. Not only is their danger greater in this group, even with the milder varieties, but their use is less often required for reduction. The displacement of fragments is more easily overcome, and often a less exact replacement is indicated than in younger patients. During attempted reduction we must be even more gentle than usual, for these older tissues deserve the respect their owners do.

It is perhaps in the *application of splints* that the greatest care should be observed. Old tissues are very susceptible to pressure and any interference with the circulation must be avoided as far as possible. Bony prominences must be protected lest the skin become irritated or necrose. Bandages must be applied with unusual care as less encircling pressure is needed to interfere with circulation when the blood-vessels are stiff and inelastic.

Active and passive movements, the use of heat and electricity, are indicated earlier but must be carried out with even greater gentleness and under more expert care than in younger patients. The duration of the period of disability as well as the consequent amount of disability will depend more on the wisdom and the skill with which these measures are carried out than on any other factor in the treatment. Too rough massage, movements carried beyond the painful limit, can do great harm, prolonging the period and increasing the amount of disability and adding to the total suffering. Unless these details can be wisely, skillfully and gently carried out they had better be omitted entirely.

In handling fractures our decision as to many details should be largely influenced by the use which the individual must make of the affected part. To illustrate, let us suppose a musician has injured his left wrist so severely that we feel confident that there will be some permanent impairment of rotation. If he is a violinist he will need complete supination, but this position would not be of much use to a piano player.

In the aged this problem differs from what it would have been in their earlier, more active days. It is not as essential for them to have either the extreme range or the full return of power. Their lives no longer demand the strength or the power or the delicacy and agility of finer movements. Nor again is deformity as distressing to them as it would have been thirty or forty years before. They badly need a moderate amount of power,

range of movement and dexterity but they can well afford to sacrifice the extremes of all three to be sure of the moderate amount and especially if this can be obtained without persistent pain.

But we must also remember that they have less reserve and that their margin of safety is less. Their muscles are already weakened and flabby, their joints none too limber and their agility decreased. We therefore must aim for function rather than anatomic perfection of bone. All of these factors must be considered. Each individual case should be studied in all its aspects and a wise decision made as to how completely rest is indicated, both local and general, the relative advantages and disadvantages of anesthetics, the completeness of the reduction of any existing displacements, the duration of splintage, the time and extent of massage and movements.

We can be braver in our use of splints than we can with our younger patients. These people are less subject to violence and less apt to suffer recurrence of the displacement. The retentive bandage should be used with unusual care. In many cases splints can be entirely omitted, using sling, swathe or perhaps suspension. These people need more frequent visits with careful inspection and meticulous care of the skin. Above all must we try to avoid or overcome the stiffness in the joints and the atrophy of the muscles. Gentle massage and gentle movements, active and passive, must be instituted as soon as possible.

The prognosis in fractures in the aged is not as good as in the younger age groups, either for life or for the function of the part. Their margin of safety is already decreased and their susceptibility to the various complications of injury is far greater.

The prognosis depends quite as much on the condition of the patient and on the character of the treatment he receives as on the details of the fracture itself.

The chances of life in the severer types of injury, such as fracture of the femur, have improved tremendously since methods of treatment have been developed that permit of earlier movement in bed with the sitting posture. Thanks to Whitman, Blake and others, there are many old people walking around now who in former days would have spent the short remainder of their lives in bed.

To summarize:

1. Treat the patient even more than the fracture.
2. Strive for function rather than anatomical perfection.
3. Avoid pressure.
4. Be *gentle* in reduction, in the use of appliances in massage and in movements.
5. Again—be gentle.

DIFFICULTIES IN THE REDUCTION OF FRACTURES OF THE LONG BONES AND THE PRINCIPLES OF TREATMENT

JOSEPH A. BLAKE, M.D., F.A.C.S.

NEW YORK

I believe that traction is now generally conceded to be the best agent we possess to produce and maintain reduction of fractures of the long bones. By its use longitudinal displacement, that is, overriding of the fragments, can be overcome and their ends may even be pulled apart so as to disengage interlocking and permit their proper reposition upon relieving the excessive tractive force. Traction may be applied more easily and successfully to the reduction of fractures of some bones, notably those of the arm, thigh and leg, than others; but fractures of the phalanges, metacarpals and even the clavicle are susceptible to its use.

On account of the brief time allotted to me, it will be impossible to cover the details of the application of traction to different fractures and, therefore, only the principles involved will be considered.

In the first place, the difficulties encountered in the reduction of fractures of the long bones are, in the main, three in number, namely: interlocking of the fragments; interposition of the soft parts, chiefly muscle tissue; and delay. Of these three the most important and the one that is not generally recognized is the last, *delay*. The first two may be dismissed with a few words. Interlocking can usually be overcome by traction. Interposition of the soft parts when so great as to seriously interfere with union calls for an open operation.

Delay means swelling. In most fractures if reduction is obtained at once swelling is obviated, and in all is less than when reduction is delayed. Swelling is produced by hemorrhage, by exudate of serum, and by migration of cells in the effort to repair. When the soft tissues are torn apart from each other and from the fragments of a bone, particularly when overriding, spaces are formed and the ends of the torn vessels are free to empty into these spaces. The hemorrhage that ensues causes pressure and may even crowd the lacerated soft parts between the fragments. All the torn soft parts swell also and their enlargement may force them between the fragments. Later, organization of blood clots, round celled infiltration and soft callus make reduction impossible by any closed method. On the other hand, if a fracture is reduced at once, particularly by traction and not manipulation, for the latter is apt to augment the injury to the soft parts, the enveloping sheath of soft parts is stretched longitudinally producing lateral pressure upon the fragments, thus tending to reduce them, obliterating spaces and, by compressing the vessels, checking hemorrhage. Traction before swelling occurs is far more effective than afterward, for it takes much less force to produce reduction. This is so because the soft tissues permit only a definite amount of stretching, and when distended laterally cannot be stretched longitudinally. Delay, therefore, is perhaps the chief obstacle to successful reduction of fractures of the the long bones.

In regard to the principles of applying traction, I believe a distinction should be made between traction to produce reduction, and traction for maintenance of reduction.

In general, reduction should be obtained as rapidly as possible for the obvious reasons already stated. This calls for a maximum tractive effort exerted over a short time. As soon as reduction is obtained the tractive force should be reduced

to that sufficient to keep the fragments in place. Unfortunately, there are always cases in which reduction has been delayed and in which swelling has occurred. When this is so the soft tissues cannot be stretched out quickly and consequently a considerable tractive effort has to be maintained for a relatively long period. But even in these cases it must be remembered that repair is going on rapidly and reduction is becoming more and more difficult.

Traction is applied in many ways in reducing fractures and the method used for reduction may not be suitable for the continuation of treatment. Not infrequently it is not employed after reduction is obtained. For example, most Colles' fractures are reduced by traction whether by direct pull or by crowding the manipulating hands together. Fractures of both bones of the forearm may be reduced by engaging the fragments of one bone and, using this engagement as a fulcrum, tractive effort is used in reducing the other. In some of these fractures, however, traction may be used advantageously for maintaining reduction.

Traction applied in the first aid treatment of a fracture, as for transportation, is an example of an application unsuited for continued treatment, but of the greatest importance because reduction may be accomplished by it and much time and suffering be saved. With a Thomas splint and a hitch over the boot, fractures of the femur and even of the tibia and fibula may be practially reduced at the most favorable moment. The same is true of fractures of the upper limb, a hitch being placed about the wrist. Obviously, in these cases the hitch should not remain over an hour or so. The Delbet method of treating fractures of the tibia and fibula is an example of the possibility of early, rapid reduction by traction and of the avoidance of swelling by early reduction. In this method a muslin bandage four or five inches wide is slit at its middle for a distance just sufficient to permit the foot to pass through it. It is then turned crosswise so that when the ends of the bandage are pulled, one half of the bandage engages above the heel and the other above the instep. With the patient lying on his back on a hard flat table, the ends of the bandage are brought over a tin can acting as a pulley, and are attached to a sixty pound weight. The method is painful, but reduction is accomplished in about twenty minutes and tight molded plaster splints are applied with the traction remaining on until they harden. It is remarkable that, although encircling plaster of Paris bands are put over the molded splints at the ankle and just below the knee, they rarely have to be removed because of swelling.

Traction, both for reduction and for treatment, is instituted usually through some form of adhesive applied to the skin (skin traction) or by means of tongs or pins inserted into the bones (skeletal traction). In skin traction some of the force is transmitted by the skin and deep fascia to the proximal fragment, while in skeletal traction the force is applied directly to the distal fragment or to it through the ligaments of a joint. Consequently, less force to produce the same results is necessary in skeletal traction. In skin traction only a certain amount of traction per square inch of skin is permissible or blistering will occur. Also the skin of some persons is more susceptible to blistering than others. Consequently, care and judgment must be exercised. However, most skins will stand for three or four hours a relatively large pull, perhaps three or four times that which could be borne for twelve hours. In early fractures this can be taken advantage of and reduction accomplished, when the traction should be reduced to a safe amount. In older fractures in which swelling has occurred and particularly in those of a week's standing or longer, skin traction should not be employed for these cases require strong pull over a long period and skeletal traction is necessary.

Traction may be exerted by weights, by springs or by screws or straps. The first

two methods produce constant traction; the latter two pull the parts to a certain point and hold them without exerting further active traction. Each method has its followers. I prefer weights and pulleys as I am enabled with them to employ suspension more efficiently. The other methods require some form of splints while with weights and pulleys splints may be unnecessary in some fractures, as for example, of the humerus.

Traction, we have found, is the best fixation agent in preventing angular as well as longitudinal deformity. It tends, of course, to pull the fragments into a straight line. This may not be correct as the bone normally may be curved. By varying the direction of traction and the lateral forces produced by suspension, as perfect reduction as is possible usually can be accomplished.

The stretched sheath of muscles surrounding the fragments tends to keep them in alignment. When the proximal fragment is so short as not to be controlled by this sheath, it is necessary to make the line of traction conform to the position occupied by the fragment. While this is the rule to be observed in maintaining reduction, there are exceptions, too, in producing reduction. For example, in some fractures of the surgical neck of the humerus the proximal end of the distal fragment is engaged under the mesial surface of the head, being held there by the pectoralis major, and the fractured surface of the head is directed in marked abduction. In order to disengage, traction should be applied in marked adduction pulling the arm cross the chest until the muscles are stretched. Then gradually, 15 or 20 degrees at a time, the direction of traction is changed until it coincides with the position occupied by the proximal fragment, that is in full abduction.

Some of the high fractures of the shaft of the femur present difficulties in reduction. The proximal fragment, as in fractures of the humerus, tends to occupy a position of marked abduction and it is often difficult to get and keep the distal fragment in line with it. In addition to relaxing the muscles by flexing the knee, pressure pads may be necessary to prevent lateral bowing at the fracture particularly in the later stages of consolidation when strong traction cannot be continued. In these cases skeletal traction is necessary as a rule, because skin traction cannot be applied with the knee flexed.

WHEN IS THE OPERATIVE TREATMENT OF FRACTURES OF THE LONG BONES JUSTIFIED?

CHARLES L. SCUDDER, M.D., F.A.C.S.

BOSTON

THIS is the appropriate place and an opportune time for a symposium on so important a subject in traumatic surgery as the treatment of fractures. I appreciate the honor of the invitation to be one of the speakers on this occasion. This geographical center, New York, has contributed to our knowledge of fractures in the past through the activity of various individuals, notably Moore, Mott, Sayre, McBurney, Wyeth, Hamilton, and Stimson. There is here in New York today a veritable host, a large group of men, enthusiastically and profitably engaged in securing facts concerning all phases of this complicated fracture problem. It is naturally to groups of this kind that we look for assistance in the solution of the vexed and still unsettled fracture questions. I cannot hope, therefore, to present to this audience new data upon a subject attracting here such acute attention. All I can expect to do is to state certain details relevant to the question raised, and express my personal opinion.

When is the operative treatment of fractures of the long bones justifiable? My reply is briefly: Whenever the operative treatment is needed to secure the best result following a given fracture.

It is unfortunate that today large groups of dependable cases are not available for study and comparison.

I can personally recall watching with awe thirty-five years ago, Dr. J. Collins Warren, the attending surgeon in my Ward 28 at the Massachusetts General Hospital, score or slash a closed fracture of both bones of the leg for impending gangrene, due to the tension from hemorrhage following damage to important vessels below the knee. The posterior and anterior tibial pulses were absent, the toes and foot were blue and cool. By these incisions Warren rendered a closed or simple fracture compound or open! The outcome of this logical and bold step was watched with apprehension. The man recovered with a sound leg. Compare this episode with the certainty, assurance, and boldness accompanying a premeditated incision to the bone today. The change in attitude toward such a procedure is almost unbelievable.

I can recall the bitter arguments had at this same time by two master surgeons over the use of absorbable vs. non-absorbable suture material in fracture of the patella. At that time fracture of the patella was the only closed recent fracture treated occasionally by operation. I remember with what glee one surgeon heard of a refracture of a healed patella sutured by the other with silver wire! Of course, the refracture was thought to have been due to the use of the non-absorbable wire, and this refracture was thought to have more than justified the use of absorbable suture material!

Those were stirring times, indeed. Personal feeling ran high. We youngsters shared in the excitement and of course took sides with our chiefs. We discussed the problems at issue. Our chiefs nursed their temporary personal enmities engendered by differences in surgical technique and opinion. Those were days of military conformity in surgery. The climate of surgical opinion was foggy. The balanced and enlightened surgical mind of today was in the making. Doubtless some of you can duplicate these experiences here in New York. What a great contrast between then and now. Timidity has given place to boldness, emergency measures to premeditated direct operations.

The operative treatment of fractures has come to its present important place as a recognized part of general surgery gradu-

ally, progressively, and comparatively recently.

All real advance in the art of surgery is and must be individualistic. The sixteenth century saw the rise of modern science. Copernicus and Vesalius typify the scientific emphasis on direct observation. The quiet growth and dissemination of science has colored our ways of thinking.

William James wrote, "I have to forge every sentence in the teeth of irreducible and stubborn facts." Surgeons are now more absorbed than ever in stubborn facts and in the weaving of general principles. This balance of mind, interest in fact and generalization, has become part of the tradition that infects cultivated thought. This tradition of a balanced surgical mind is being transmitted as a widespread, fortunate inheritance from generation to generation by our university medical schools and hospitals.

Following the recognition in the sixteenth century of the importance of observation and the necessity of recording these observations, there came in the nineteenth century the influence of anesthesia, of antisepsis, of asepsis, and of the roentgen ray.

In the nineteenth and twentieth centuries were taken the remarkable strides toward the perfection of neurologic surgery, the surgery of the thoracic organs, abdominal surgery, including the gastrointestinal, genitourinary, and pelvic organs. Diseases of all these various organs often killed the individual. The pathology of many of these diseases was generally known. Consequently the best brains of the time took cognizance of relief through appropriate surgery. "As is our pathology so is our practice" (Osler).

Fractures of the skeleton rarely killed—only deformed, crippled, and incapacitated. When it was recognized that fractures killed, as in compound or open fractures, Pasteur and Lister immediately greatly diminished the mortality from this dire condition. Today an ordinary civil compound fracture is safe. "As is our pathology so is our practice."

Fractures continued to be treated unsatisfactorily. In large numbers the long lines of disabled and crippled kept limping on.

The industrial awakening of the nineteenth and twentieth centuries, the appearance of complicated machinery have been a tremendous stimulus to the surgery of fractures.

The limb involved is regarded properly as a part of a complicated and coordinated, intelligent, mechanism. The limb is interrelated with the fibrous tissue and bony tissue of the part. Likewise, the muscular, vascular, and neurological structures are influenced by changes in the limb. Even temporary disuse affects these structures. The damage to the limb by fracture may be intimately connected with metabolic and hematogenetic processes as well. The long bone *is* a part of a complicated mechanism.

The industrial importance of the individual with a fracture relates him to the economic and social structure in a very definite manner.

Today a more precise conception of bone is arising. Bone is not a dry, inert, stable, terminal form of matter; it is a living, unstable, changing tissue, sensitive to all extraneous influences and events.

The reaction of bone tissue to fracture, to trauma, is recognized as a complicated series of events—the processes of repair. These processes and many of the influencing factors are being intensively studied. The final word is not yet.

Whether the healing of bone is a physical or chemical process or a combination of the two, is as yet undetermined.

What the exact function and origin of the cells concerned in the reparative processes are, is unsettled. For our purposes in this discussion, it may be affirmed without fear of contradiction that an appreciation of these conceptions of repair, even though incomplete, has had and is having a profound influence for a sane treatment of fractures. "As is our pathology so is our practice."

It is a stimulating thought, and I believe a logical one, that the serious discussion of the operative treatment of fractures coincides with the technical perfection of pathological surgery. This is not a mere coincidence. General surgery has been improving, developing up to and for this event. It was impossible for the treatment of fractures to develop adequately until this perfection in surgery had been attained.

The recognition of the functional importance of crippling due to fracture has been growing for some years. The industrial awakening to the economic value of this loss of function from fracture is a development of recent times.

That the limb is a part of an intelligent machinism, that the will is involved in every fracture, that it influences the recovery of function—the significance of these facts is too little appreciated.

That bone is related to other tissues; that a fracture of bone is very intimately and complexly related to all parts of the body in ways as yet not entirely understood—these are comparatively recent facts and are bound to have their influence on treatment.

That bone is a delicate tissue, that it demands and requires consideration because of its peculiar qualities is a recent thought. That it must be gently handled in manipulation and at operation is coming to be appreciated.

All these facts together, with the perfection of general surgery, should influence profoundly our appraisal of the operative method of treating fractures.

It may not be amiss here to state that attempts to popularize anything novel in the art of surgery is unwise. Such popularization is bound to be followed by terrible results and disasters, as seen, for instance, in this country after 1909, when statements of the possibilities of the operative treatment of fractures were promulgated. Lives, limbs, the power to earn a livelihood, were sacrificed in the popular attempts to improve fracture surgery by indiscriminate operating. The non-operative methods were inadequate. The logical direction for improvement at that time lay in a better non-operative treatment. Those times were not ready for the operative treatment to be generally adopted.

In my personal estimate of the operative treatment of fractures I assume that the fractures under consideration are seen immediately following the injury, that is, that they are recent fractures.

The long bones to which I refer are in the upper extremity—the humerus, the radius, the ulna; in the lower extremity—the femur, the tibia, the fibula.

This includes fractures that enter the shoulder, elbow, and wrist joints, and fractures that enter the hip, knee, and ankle joints, as well as, of course, fractures of the shafts of these six long pipe bones.

By the *non-operative treatment*, I understand that treatment which honestly employs:

1. The suspension of the limb;
2. (Adequate) traction;
3. (Adequate) counter-traction;
4. A proper hold on the limb of the traction force;
5. Manipulation;
6. Pressure;
7. Counter-pressure;

and secures:

8. The alignment of the limb, and
9. The movement of involved or contiguous joints as early as possible.

By the *operative treatment* I understand that method which approaches the seat of fracture through an incision. The fracture is directly treated.

I would also include in the operative treatment any procedure that necessitates the making of a wound to facilitate treatment, that is, a tenotomy, the application of a pin or calipers. When reference is made to the operative treatment through caliper or pin, the fact is specifically mentioned so that there may be no misunderstanding.

I assume by the operative treatment:

1. That the highest degree of safety to the individual will obtain,

2. That the surgeon and assistants are skilled in the use of the treatment;

3. That the surgeon possesses ability more than that needed for ordinary care legally required;

4. That the surgeon has available necessary instruments and apparatus;

5. That the employment of that form of anesthesia applicable to the case in hand, whether regional, local, spinal, or general, will be skilful;

6. That the conduct of the operative treatment so far as the preoperative and postoperative care is concerned is adequate;

7. That the final and exact procedure chosen in the operative treatment of a given case is appropriate;

8. That by this treatment the involved or contiguous joints are moved as early as is possible.

What are the conditions and the facts to be considered in formulating an opinion as to the applicability of this operative treatment to fractures of the long bones?

1. A trial of the nonoperative treatment may be made for ten days; if it is then found to be unsatisfactory, the operative treatment may be used.

2. Skeletal traction will accomplish more than skin traction and by its efficancy may take the place of the open operation.

3. The number of open operations is being somewhat diminished by the increasing efficient use of skeletal traction.

4. The operative treatment may secure perfect reduction.

5. Absolute fixation may be had by operation.

6. Perfect reposition is desirable, for perfect reposition means more perfect function.

7. Restoration of good form to a broken bone gives a chance of nine to one in favor of good function. Allowance of bad form will give a chance of two to one against a good result (Hey-Groves). This is not an accurate estimate but it is suggestive.

8. The operative treatment is a safe treatment.

9. Infection is eliminated.

10. The dangers from the sequelae of sepsis are eliminated.

11. An uninterrupted movement of joints is desirable after fracture. Absolute reduction and fixation of the fracture fragments permits of the earliest movement at the seat of fracture.

12. The operative treatment will permit the maximum early movement in contiguous or involved joints.

13. Delayed union and non-union are not caused by direct treatment. I am not convinced that operation increases the likelihood of non-union.

14. Foreign non-absorbable materials are not always employed in the operative treatment.

15. Non-absorbable steel plates and screws and their equivalents are not irritating, if properly used.

16. Forcible manipulations required by the non-operative treatment may do actual harm and may be the occasion of delayed union.

17. Poorly conducted and poorly applied non-operative methods each may give poor results.

18. The results from a poorly conceived non-operative treatment should not be compared with the results from an ideal operative treatment.

19. Only similar kinds of fractures treated by well conducted methods should be compared.

20. The treatment will be modified to suit the social and industrial status of the patient.

21. Immediate, early reduction is desirable by both methods.

22. Operation is justifiable after trying non-operative treatment.

23. Operation is justifiable as an initial treatment in an increasing number of cases.

Fractures in children—the growing period. The wonderful compensatory power of growth is depended upon to make up for the deficiencies of non-operative treat-

ment. How far should this "compensatory power" be permitted to influence treatment? It should not be permitted to influence the treatment of fractures in the lower extremity as it may in the upper.

In the upper extremity in childhood:

Certain fractures of the upper end of the humerus, high surgical neck fractures, I believe are best treated by operation and simple reposition, possibly without internal fixation. (Incision, digital confirmation, leverage, fluoroscopic reduction.)

In fracture of the external condyle of the humerus with displacement of the small fragment, the broken part should be accurately replaced by operation.

Certain irreducible supracondylar fractures of the humerus should be replaced by incision and direct leverage.

A few fractures of both bones of the forearm that cannot be reduced by gentle manipulation may well be reduced by incision and leverage.

Fractures of one bone of the forearm irreducible by manipulation may be well reduced by incision and leverage.

In the lower extremity in childhood:

Skeletal traction will replace almost all operations on the femur.

Most femur fractures can be satisfactorily reduced and held by the non-operative method.

Fractures in the adult.

Upper extremity. Mobility is desirable.

Operation should be done upon:

Fracture of the high surgical neck of the humerus and dislocation of the head;

Irreducible, high surgical neck fracture;

Transverse fracture at the middle of the shaft if apposition cannot be secured:

It is so difficult to be sure whether a musculospiral paralysis associated with a fracture of the humeral shaft is due to a divided musculospiral or to a contusion of the nerve, that is a complete or a partial paralysis, that I am inclined to treat the fracture expectantly and delay operation on the nerve. Having secured union of the bone, if the nerve is not permanently damaged, its recovery will be evident when the bone is united, and there will not have resulted undue loss of time in the nerve repair by the delay.

A T-fracture into the elbow joint in an adult should be operated upon if the joint surface cannot be absolutely restored by position, and this is usually impossible.

The neck and head of the radius should be operated upon when the resulting deformity from displacement will impair notion.

Operation should be done upon both bones of the forearm, if accurate alignment cannot be immediately obtained. If the radius or the ulna is fractured with displacement of the fragments, operative replacement is indicated.

Lower extremity. Stability is desirable.

The neck of the femur: There should be no primary operation on a fracture through the middle of the neck of the femur. When it is proved that the fracture is not uniting, operation may be done.

Shaft of the femur: In wage-earning laborers and in young adults there are many fractures of the upper, middle, and lower third that I prefer to operate upon.

Fractures of one or both femoral condyles are best operated upon.

Spiral fractures of both bones of the leg are best operated upon.

Fractures involving the ankle joint should be operated upon.

Skeletal traction in certain oblique femoral fractures will reduce and hold the displacement.

Opinions as to the desirability of operation vs. non-operation must rest on accumulating facts. We have today very few facts from dependable sources. The best returns in adult fractures are the more or less comparable cases from the clinics of Sherman in Pittsburgh, Campbell of Memphis, Tennessee, and Conwell in Alabama. In the femur shaft cases, in husky young adults, all these clinics are securing splendid results: one clinic by operation, steel plate and steel screws; one clinic by anesthesia, traction, counter-traction, manipulation, reposition, and plaster of Paris

splint; the other clinic by skeletal traction and plaster fixation. The treatment by operation with plate and screws seems to give a little earlier return to work than do the other methods. An average return to work from five to six months is a satisfactory achievement following fracture of the shaft of the femur.

My contention, and this is the hopeful thing about the matter, is that we have two very efficient methods of treatment, each requiring further use and careful recording. As the data accumulate, we shall get nearer and nearer to the propriety of stating at the outset, as to a certain fracture, this case should be operated upon at once, in this case the non-operative treatment will be satisfactory.

We may feel, I believe, that the operative treatment of fractures has come to occupy a definite and established place in general surgery. It is no longer a last resort in treatment. It is an initial method of choice.

I should like to state here, and it seems to be appropriate to this discussion, my conception of the qualifications of fractures. This statement may serve to epitomize the ideal reply to the inquiry, When is the operative treatment of fractures of the long bones justifiable?

There are at least eight factors necessary to the qualification of a surgeon operating upon recent closed uncomplicated fractures:

1. An adequate knowledge of the patient, physically, mentally, socially, industrially.
2. An exact knowledge of the local conditions under consideration in the individual case.
3. Perfect instrumental, mechanical, and physical equipment including access to Roentgen-ray apparatus.
4. An accustomed, proved operative technique, delicately balanced.
5. An understanding of the sensitive nature of bone tissue, its reaction to injury, and the conditions influencing the process of repair.
6. A practical experience in the successful treatment of certain fractures by modern non-operative methods.
7. A knowledge of the various operative procedures for the immobilization of fractures.
8. An open mind in choosing the method best adapted to the case in hand.

A surgeon having the above qualifications is capable of safely treating fractures by operation. A surgeon not having these qualifications should not employ the operative method in treating fractures.

The only underlying fundamental reason justifying the ideal operative treatment of a simple, closed, uncomplicated fracture is the probability of effecting an earlier return of the part to a more nearly normal function than can be secured by any other treatment.

It is established that in skilled and sane hands the operative treatment of certain recent closed fractures is a safe procedure, with an almost negligible mortality risk, and with a high percentage of restored normal function in a reasonable time.

It is also established that in skilled and sane hands the non-operative treatment of certain recent closed fractures is a safe and satisfactory method of treatment, securing a high percentage of restored normal function in a reasonable time.

It should be the aim of every surgeon of traumatism treating fractures to perfect himself in both these methods. The one method demands as much training and skill as the other. A complete knowledge of the advantages and the technical details of each method is essential to the highest efficiency.

A general surgical training combined with a special technical mechanical training affords the most nearly ideal preparation for the treating of fractures that is possible.

Summary

If you are a master of the general principles and technical details of both external and internal fixation and are informed as to the results of such methods of treatment, and have a complete knowledge of the proper use of massage and active movement and can secure the patient's complete

cooperation, your vision of the surgical treatment applicable to a given case of fracture of bone will be so broad, your selection of the treatment will be so wise, and your execution of the treatment chosen so ideal that the result both functionally and anatomically will be the best obtainable for that particular individual under the local conditions and environment found existing.

The way to improve treatment is in three directions:

Undergraduate instruction;

Graduate instruction;

Lay propaganda.

1. A great constructive movement is on foot to secure better undergraduate medical student instruction. It is having its effect.

2. A great movement is already under way in the United States to enlighten and sympathetically help the general practitioner in his handling of fractures.

3. Some appropriate day there will be an illuminating lay propaganda on fractures. Such propaganda will accomplish for fracture treatment somewhat the same result that already has been so well accomplished for cancer treatment. Such lay propaganda will provide the workman with the idea of where to find the best treatment and what he may reasonably expect from the treatment instituted in his behalf.

Perhaps the day will never come when the free choice by a workman of the physician he employs when injured will be done away with, but the corporation and the insurance companies already recognize that they are together spending in this country and in this State millions of dollars for unsatisfactory initial treatment, resulting in long disability and in long reconstructive treatment. Initial bad treatment is the occasion of most of the expensive reconstructive treatment.

Along with the above-mentioned movements, which are really irresistible, there are:

1. The equally important research laboratory investigations on bone repair;

2. The focusing attention in every large and small hospital upon each fracture patient as a peculiar problem requiring skilled attention;

3. The discussion by interested surgeons, on fracture services throughout this country, of the various problems coming up in individual cases of fractures;

4. The exchange of experiences between surgeons in the friendly visiting clinics;

5. The direct and intimate association of these experienced and inexperienced men in the care of these cases, transmitting thus habits of thought and details of treatment, creating thus a climate of surgical opinion that will find its way to the remotest community.

From all these accumulated and accumulating experiences, facts are being arranged in an orderly fashion, from which will eventually emerge further sane and efficient practical suggestions, valuable for the general practitioner and for the surgeon.

THE CAUSE AND THE TREATMENT OF NON-UNION

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NEW YORK

NON-UNION is the result of some interference with the normal sequence of events in the repair process in bone. Under normal conditions a fracture is followed by an exudate rich in fibrin, which coagulates and which is infiltrated by a rich cellular exudate from the periosteum and the endosteum. These granulation tissue masses form about the end of the bone with great rapidity and rapidly fuse with each other. Coincident with the above the cortical bone ends become rarefied (osteoporosis).

FIG. 1. A. M. Non-union due to interposition of radial nerve.

FIG. 2. A. M. Eight weeks after introducing intramedullary beef bone dowel, showing abundant callus. Beef bone dowel probably unnecessary.

Calcification of the granulation tissue occurs on the periosteal as well as on the endosteal side of the fracture and this calcification and the osteoporosis proceed until the newly formed bone and the cortex are approximately of the same density, when a readjustment takes place and the newly formed bone and the eroded cortex become denser and new bone is laid down in concentric lamellae parallel to the lamellae in the preexisting bone. Different lengths of time can be assigned to these various stages depending on the variation in the size and density of the bone to be repaired and in the amount of repair substance needed.

Adhesion of the periosteum, the interposition of muscle or of a bone fragment across one end of the fracture will prevent coalescence of the granulation tissue masses or their formation. A too wide separation of the fragment or a loss of bone substance may require too great an amount of newly formed tissue to bridge the gap and the sequence of events may be so interfered with that calcification at the bone ends causes plugging of the medullary canal and sclerosis of the cortical bone at the line of fracture, and the distal granulations become anemic and cannot proceed to proper calcification. If to the above is added more

or less constant motion of the fragments the terminal granulations tend to form cartilage and a rather thick viscid liquid forms with the production of a pseudo-arthrosis.

Infection at the site of fracture also may alter the sequence of tissue changes necessary for the repair process by causing the granulation tissue masses to break down

Fig. 3. R. G. Non-union, both bones of forearm, due to frequent manipulation, late operation (bone graft with infection).

Fig. 4. R. G. Autogenous intramedullary multiple graft with osteoperiosteal graft in radius. Inlay graft in ulna.

Fig. 5. Non-union due to interposition of muscle.

Fig. 6. Same type as Fig. 5 but different patient showing intramedullary graft from tibia.

or by preventing a proper osteoporosis of the bone ends by causing necrosis of the bone.

A large fragment of bone deprived of its circulation may also divert too great a number of osteogenic cells to itself and permit osteosclerosis of the bone ends to occur at a period too early for the proper coalescence of the granulation masses; and in the process of readjustment these eburnated bone ends are left ununited, or in the neck of the femur the head fragment with a poor circulation remains unaltered while the osteoporosis of the shaft fragment enlarges the gap between the bones, causing non-union.

As a result of treatment the normal sequence of events may also be interfered with. For example, too frequent manipulations of the bones, especially late, may cause interference with the interlacing of the granulation tissue and leave a gap between the masses. In a somewhat similar manner an operation may disturb this sequence of bone repair and produce masses of new bone which do not unite and which undergo retrogressive changes into dense bone before the two fragments have become joined together.

The distinction between delayed union and non-union is often one of opinion. I prefer to reserve the term non-union to that group of cases in which motion persists at the line of fracture, with a roentgenogram that shows among other things:

(1). Sclerosis of the end of the upper fragment with an irregular bulbous formation of bone and closure of the medullary cavity by dense bone.

(2). A more or less distinct line between the two fragments.

Fig. 7. J. B. Non-union, both bones of forearm. Compound fracture with infection, marked atrophy of distal fragments.

(3). The upper end of the lower fragment consisting of sclerotic bone. Beneath this the cortex is thinner than normal and the medullary spaces wider (atrophy of bone).

(4). Absence of the normal subperiosteal bone across the line of fracture.

In cases of delayed union it is often possible to say that non-union is going to occur from repeated *x*-ray observations in which the above changes can be seen to develop especially the closure of the medulla by bone which gradually increases in density.

Until the term non-union comes to mean essentially the same thing everywhere, different treatment and differing results will occur because the conditions treated are so essentially different. An operation to hasten union is certainly not an operation for non-union and many of the procedures described for non-union are in essential details only procedures to hasten union in the delayed cases. They fail naturally enough in the cases of real non-union.

Fig. 8. J. B. Massive inlay graft counter-sunk into lower end of radius; osteoperiosteal graft about fracture line in ulna.

In the management of non-union the bone ends must be so treated that there is produced a condition similar to that which occurs in a fresh injury, namely the medullary cavity must be opened, the density of the sclerotic bone must be altered by drilling or otherwise, the atrophic cortex in the peripheral bone must be stimulated to regenerate and fresh blood clot must be brought between the bone ends. Many methods have been devised for this purpose, such as reshaping the bone ends, by various doweling and step operations, by drilling the bone and by fixation with various materials. The best result is procured by some form of bone graft, preferably autogenous, which opens up the sclerotic bone ends and also prevents motion at the site of fracture.

The character of the bone graft will vary with the fracture to be treated and that form of graft essential to meet the conditions of the individual case must be left to the operator. Fixation will require a heavy graft, especially where correction of displacement is an essential part of the treatment. Loss of bone requires a heavy graft both to restore the bone length and to retain its position during the period of regeneration. In order to produce repair more rapidly an osteoperiosteal graft should be added because of the more rapid bone repair that results from the osteoperiosteal graft.

In certain bones, and because of certain technical difficulties, an intramedullary

graft may meet the indications better than the inlay graft. The chief objection to the intramedullary graft is that it plugs the medullary canal and delays rather than promotes union. This can be met by using several small intramedullary grafts which allows for spaces between them, and also allows for more rapid vascularization of the graft. One technical error usually made is that these grafts are not sufficiently long to reach to normal bone and medulla on each side of the line of fracture. In addition, failure will be less frequent when the intramedullary graft is reinforced by an osteoperiosteal graft about the outside of the bone.

In cases of marked atrophy of the distal fragment counter-sinking the end in the distal fragment not only helps in the proper fixation of the graft but brings the graft in close contact with healthy bone trabeculae and stimulates a more rapid regeneration of bone.

In cases with marked sclerosis, especially in the smaller calibered long bones, multiple small grafts inlaid along the sides of the bone have given more certain results and more rapidly than a single large graft. These may be fastened in position by a periosteal graft or by a fascial ligature. At present I believe the periosteum is the more efficient for this purpose because, as a rule, a number of osteogenic cells always come away with the periosteum and introduce an added number of bone cells in the desired area.

Fig. 9. D. L. Gunshot fracture of the humerus. Infection, loss of bone, marked displacement of lower fragment, sclerosis and atrophy of upper fragment.

Fig. 10. D. L. Heavy inlay intramedullary graft. Graft inlaid and pegged in upper fragment. Intramedullary and counter-sunk in lower fragment long enough to make up shortening. Reinforced by osteoperiosteal graft which shows new bone at the end of three weeks.

The American Journal of Surgery

EDITORIALS

THE JOURNAL BEGINS A NEW SERIES

With this issue the JOURNAL appears in its new dress and begins a "new series." Despite the season, the change is made thus early after the transfer to another publisher as an earnest of his promises and the editor's. This number may be taken as a fair indication of the make-up and appearance that the JOURNAL is to have. In these respects, however, further improvements are contemplated, and the JOURNAL is to be considerably larger. The collaborating Editorial Board is now almost completed. Several of its members have already been very helpful in connection with contributed articles and editorials that have been or are to be published, and we anticipate that the Board will be increasingly useful to the JOURNAL and its readers.

This issue is several weeks overdue. The delay has been incident to the change of format and of printers, and to the publisher's removal last month from the long-familiar place on 59th Street, New York, to new quarters at 76 Fifth Avenue. We ask our subscribers to forgive this unavoidable tardiness and to bear with us patiently in such delays as may still attend the establishment of the publication in its new routine. Before long the JOURNAL, bigger and better than ever, should reach them early every month.

W. M. B.

DISCARDS OF SURGERY

There is a good old English card game called cribbage. Each player receives six cards, but before the game proceeds, he must throw two into the "crib." Not a small part of the interest of the game depends upon skill in discarding, for defeat or victory not infrequently lies in the crib. For us as surgeons, if we only realize it, victory or defeat lies in the discard not less frequently than it does in the game of cribbage.

There must be a surgical discard; indeed, it is categorically more imperative to discard into the surgical crib than into the crib of the card game, because a dynamic science can develop on no other basis than that of trial and error. The more earnestly and resourcefully the trials are made, the more carefully the errors are searched for and scrutinized, the more blessed becomes the benediction of surgery. On the other hand, if the trials are made on the basis of raw empiricism, or if the results that flow from them are subjected to slovenly critique, humanity and surgery both suffer. If, in the onward march, the discard serves to emphasize immaturity of surgical thought or unwarrantable surgical radicalism, then it becomes a load of liability dangerously heavy to carry.

A large number of stomachs have been converted into gastroenterostomized "dumpers," because so many of us were willing, for years, to treat gastric ailments surgically rather than physiologically; epileptics of the *grand mal* type have been subjected first to cerebral decompression, and then to plastic repair to establish the status quo ante; ovaries have been uselessly sacrificed in order to control inoperable cancer of the breast and clitorides amputated to cure neuroses; the circulation in the legs has been reversed to overcome arteriovenous disease in spite of the fact that the contemplated vascular rerouting is unphysiological.

These are only a few of the exhibits that lie in the surgical discard—inarticulate yet eloquent testimony to immaturity of surgical thought and action, witnesses to our

failure to establish some sort of clearing house in which the process of trial and error might be worked out. Such a clearing house is a consummation devoutly to be hoped for, though its attainment is perhaps beyond reach. As a substitute, however, we may cultivate that type of philosophic doubt which has been such a valuable handmaiden to science since the days of Descartes. Or if we fear lest doubt might subject us to the charge of skepticism, we may nevertheless preserve a helpful attitude by hearkening to the poet when we are told:

"Alike fantastic if too new or old,
Be not the first by whom the new are tried,
Nor yet the last to lay the old aside."

M. G. Seelig.

PROGRESS IN SURGERY

Selections from Recent Literature

DeCourcy, Joseph L. Cincinnati, O. The Prevention of Post-Operative Thyrotoxicosis by Post-Operative Iodinization. *Ann. Surg.*, Phila., June, 1926, lxxxiii, 768.

Toxic adenoma has not been benefited, in DeCourcy's experience, by iodine medication, and he believes in a number of instances it has made these cases more toxic. However, Lugol's solution has changed the handling of these cases in many instances.

In most goiter clinics it is considered more difficult to handle extreme toxic adenoma than any other type of goiter, including the exophthalmic. Ligation and preliminary iodine medication are of no value. During the past year DeCourcy has handled all of these cases in the following manner and has had no deaths, although a great many were in extremis and were suffering from decompensated goiter hearts.

The patient is placed at rest in the hospital. If there is decompensation, sufficient digitalis is given (gtts. 10 every four hrs.) until compensation returns. If there is no decompensation and the heart beat is regular, then the patient is digitalized with three doses of tincture digitalis of thirty minims each, about ten hours apart. A soft diet is given and they are encouraged to take large amounts of water and fluids. One-half hour before operation the patient receives morphine gr. ¼, atropine gr. 1/150.

The operation is performed under nitrous oxide-oxygen and both lobes and isthmus are removed. The wound is left open and packed with saline gauze. As soon as the patient returns to bed she receives thirty minims of Lugol's solution per rectum. This is repeated in 8 hours. Fluids are given per rectum and encouraged by mouth if they do not cause nausea. The following morning the wound is closed with gas anesthesia, in the room.

DeCourcy has noticed a remarkable improvement in the convalescence of these patients with an absence of the muscular tremor, tachycardia, restlessness, and fever which were so common before. He looks upon post-operative thyrotoxicosis following removal of toxic adenoma the same as that following exophthalmic goiter and believes that both may be prevented by immediate post-operative iodinization.

In the mixed exophthalmic and adenomatous gland, iodine has not been of value in the preoperative treatment, but it has been of distinct value post-operatively.

Sanger, Bertram J. New York. Exophthalmic Goiter. A Follow-up Study of Cases Treated with the Roentgen Ray. *Arch. Int. Med.*, Chicago, May 15, 1925.

Fifty patients with exophthalmic goiter were carefully studied under roentgen-ray therapy. They were followed at frequent intervals during their course of treatment and subsequent to their recovery, with basal metabolism and clinical observations. Some have been followed for as long as five years. The great majority, 82%, became entirely well and remained so. Of the remaining 18%, 6% were improved, 8% were operated on, and 4% were lost to the follow-up clinic during the last year, so that the ultimate result is doubtful.

On the whole, the roentgen ray offers a safe and satisfactory therapeutic procedure, with a high percentage of cures, in cases of exophthalmic goiter.

Coventry, W. A. Duluth, Minn. *X*-ray and Metastases in Breast Cancer. *Minnesota Med.*, St. Paul, June, 1926.

Concluding an analysis of 47 operated cases of breast cancer (since 1920) Coventry says: "Our observations convince us that the use of *x*-ray preoperatively and postoperatively certainly has not shown the results that were hoped and expected of it, when this series began. Whether the dosage has not been sufficient, remains an open question. I am becoming more and more convinced that postoperative *x*-ray treatment is effectual only in preventing local recurrences and relieving pain, and that from clinical experience it does not prevent metastasis but has a tendency to scatter metastasis and hurry the end."

Borak, J. Vienna. Postoperative Radiation in Carcinoma of the Breast. (*Postoperative Nachbestrahlung bei Mammakarzinom.*) *Wien. klin. Wchnschr.*, May 20, 1926.

The author has observed cases of carcinoma since 1919. He reports 34% of 6-year cures in a series of 26 cases, 46% of 5-year cures in a

series of 37 cases. When these figures are contrasted with the usual operative results of 26% free from recurrence after 5 years, and 35% after 3 years, there would seem to be an indication for the post-operative radiation of all cases of mammary carcinoma. This is particularly true in cases which at the time of operation already show adherence of skin or underlying tissues to the tumor or the involvement of axillary lymph glands. Cases that are seen before either of these contingencies has arisen usually show excellent results after operation without radiation. The technique employed in the Holzknecht clinic consists in radiating the operation site, the axilla, and the supraclavicular regions over a period of one year. Eight treatments are given at intervals of two, four, six and then eight and ten weeks. These regions are treated at a distance of forty centimeters with a dose of six H-½ HED through a 4 mm. aluminum filter with 170 kilovolts.

Risak, Erwin. So-called "Bleeding Breast." (*Sogenannten "blutenden Mamma."*) *Wien. klin. Wchnschr.*, May 6, 1926.

Bleeding breast or more properly speaking, bleeding nipple, is, in the opinion of the author, most frequently not a sign of malignancy. Erdheim's statistics show that in 70% of the cases the cause of a bleeding nipple is a papillary tumor of the excretory ducts. The next most common cause was cystic mastitis, and only third was carcinoma the etiological factor. Of 606 cases reported by Finsterer, in only 0.7% was carcinoma demonstrated. The cases in which bleeding from the nipple is seen about the period of menstruation, are to be looked on, not as vicarious menstruation, but rather as cases of blood transudation from papillomata that have become engorged at this time. The author therefore suggests that unless there be other definite signs of malignancy, local removal of the tumor is indicated rather than radical operation.

Rigler, Leo G. Minneapolis. Massive Collapse of the Lung. *Minnesota Med.*, St. Paul, June, 1926.

Massive collapse of the lung is a shrunken, airless condition of a part or all of one or both lungs, occurring suddenly after operation or injury below the neck, without the direct application of external force, or demonstrable obstruction of the air passages. Essentially, it is the same as pulmonary atelectasis.

The condition occurs most frequently following abdominal operations. It may occur after operation or injury to the body anywhere except in the head, neck, or upper extremity. The onset usually occurs in twenty-four to seventy-two hours after the trauma, and may be sudden with pain, dyspnea, tachycardia, cyanosis, and fever. In these fulminating cases, it closely resembles pulmonary embolism. Most often, the onset is slow and the dyspnea and cyanosis are the most prominent findings. Fever of rather low grade is always present and there may be leucocytosis. The patient rarely looks very toxic and may consider himself well. In a small percentage of cases, there are no symptoms, the abnormal condition being discovered on routine physical examination. Expectoration may occur but it is usually late. The clinical course is most frequently mild, lasting three to six days, the temperature not going above 120° F., and terminating by lysis. In some cases the temperature rise is present for only a few hours and the findings clear up with great rapidity. A few cases have been reported in which alternating collapse and expansion occurred over a period of weeks, the whole course lasting several months. No case of unilateral collapse without complications has ever proved fatal. Pneumonia may be a complication.

The roentgenogram affords the best method of diagnosis. There is marked opacity or mottling of the affected lung. The high diaphragm and displaced mediastinum can best be made out in this way.

Nine cases are reported.

Pringle, Seton. Dublin, Ireland. Hour-Glass Stomach: The Operation of Choice. *Lancet*, Lond., May 19, 1926.

The conclusions at which Pringle arrived as the result of experience controlled by *x*-rays are: 1. Partial gastrectomy is the operation of choice whenever possible, and the percentage of cases in which it is possible rapidly inreases with experience. 2. When gastrectomy is not feasible owing to adhesions around the distal sac, or to the high position and small size of the upper sac, a posterior gastro-enterostomy into the upper sac is the best procedure. 3. When the distal sac is large or obstruction of the pylorus or duodenum also exists, a second stoma should be provided from the distal sac into the same or another loop of jejunum. In

cases of difficulty Pringle has no hestitation in performing an anterior gastro-enterostomy with, or without, an entero-anastomosis. 4. He regards as unsatisfactory all direct attacks on the constriction either by means of a single gastro-enterostomy across the constriction (the opening extending into both sacs) or by any plastic operation such as Finney described for stricture of the pylorus.

Freund, R. Vesico-Vaginal Fistula Operations using the Principle of the Bassini Plastic Procedure on the Aponeurosis. (*Blasen-Scheidenfistel-Operation nach Art der Bassini'schen Aponeurosenplastic.*) *Zentralbl. f. Gynäk.*, Leipz., May 1, 1926.

The author makes a horseshoe incision about the fistulous opening and turns down a flap of vaginal mucosa. The fistulous opening is then excised and closed by sutures in the usual manner. The mucous membrane above the opening is sutured to the base of the flap previously turned down. The flap is then again turned upward and sutured to a newly prepared spot on the anterior wall of the vagina. In this manner the fistula is buried beneath two layers of mucous membrane. Each of the three different suture lines lies at a different level and this tends to prevent recurrence of the fistula.

Serdukoff, Prof. M. G. Moscow. Intrauterine Transplantation of the Ovaries. (*Transplantation intra-uterine des ovaries.*) *Gynécologie et Obstétrique*, Paris, 1926, xiii, No. 3.

In cases in which both tubes are impermeable, efforts have been made to overcome sterility by intrauterine transplantation of the ovaries. The author has performed this operation in two cases but does not report whether or not these patients subsequently bore children. He calls attention to the fact that in undertaking this operation efforts should be made to preserve at least one of the ovarian ligaments to insure adequate blood supply. The surfaces of the ovary directed toward the uterine cavity should be free of peritoneum. All trauma should be avoided as much as possible. The indication for this operation lies particularly in cases of complete sterility caused by disease of both tubes.

Bullard, Edwrad Arthur. New York. A Study of End-Results of Operations for Uterine Prolapse at the Woman's Hospital, 1915–1925. *Amer. J. Obst. & Gynec.*, St. Louis, May, 1925.

Bullard says that the striking thing about this study of results of operations for uterine prolapse is that about 95% of the cases are cured by vaginal plastic surgery.

The vaginal plastic work combined with ligament shortenings from above is satisfactory perhaps in cases of slight prolapse, but the careful fascial reconstruction by vagina undoubtedly is responsible for the success.

The majority of the gynecologists of today have long since ceased to attempt to cure descent of the uterus by any form of suspension or fixation by the abdominal route. Careful reconstruction of the various planes of the pelvic fascia that have become attenuated, overstretched, or torn is the *sine qua non* of the operative treatment of prolapse.

In this series, the Watkins operation has not been followed by enterocele, but there was noted a considerable percentage of cases with bladder symptoms.

The Mayo operation has been extremely satisfactory except for an occasional enterocele.

The vaginal hysterectomy by Bissell's technique has been most satisfactory, but unless perfectly done, and perhaps even then, may be followed by an occasional enterocele.

Rubritius, Hans and Schwarz, Oswald. Vienna. Contribution to the Problem of Contracture of the Neck of the Bladder. *J. Urol.*, Balt., May, 1926.

The most varied anatomical changes of the sphincter and its nerve supply lead to retention.

It is therefore impossible to bring this entire group of diseases together under one name that should convey more meaning than the mere symptom, retention.

We cannot continue to recognize the strict differentiation between structural and functional factors. The common functional factor in practically all retentions is a hypertonus of the sphincter, which is the same whether brought about by a small adenoma or by inflammatory contractions.

In one group of cases, the hypertonia stands out so markedly that it must be considered as the entire cause of the retention.

The outstanding method of treatment consists in a transvesical incision into the sphincter, with enucleation of any periurethral adenomata that may be present.

BOOK REVIEWS

YOUNG'S PRACTICE OF UROLOGY. By Hugh H. Young, M.D., and David M. Davis, M.D., Johns Hopkins University. With the collaboration of Franklin P. Johnson. Cloth. In two large 8vo. volumes; Price, $25.00. Pp. 1484, with 1003 illustrations (20 in color). Philadelphia and London: W. B. Saunders Company, 1926.

The authors note in their preface that they fear that with the recent numerous excellent contributions to urological literature, there may be a veritable "embarras de richesse." The reviewer cannot feel as keenly on the subject of "too much" as he might be inclined to feel on the matter of "too little." Quite the contrary, he is inclined to the opinion that in the special field of urological surgery, as in the wide field of general surgery, there are far too few works of the caliber of that here presented. Neither Young nor his accomplishments need any introduction to the medical public. His two volumes on the Practice of Urology represent the matured judgments formed on the basis of a study of 12,500 cases treated at the Brady Urological Institute. Not only have the case records been carefully analysed but the patients themselves have been followed up after long periods and the results of their treatment noted and submitted to careful study. It is this which lends particular merit to the work. It is essentially a practical treatise based on a wide practical experience. A large share of it is, of course, dedicated to discussion of the original contributions of the authors to the science of urology. Among these are the physiology of micturition, prostatic carcinomata, chemical antiseptics, etc.

The first volume deals with clinical aspects while the second is largely concerned with a description of the operative measures advised. In both volumes, a definite plan of grouping the various pathological mechanisms affecting the different parts of the uro-genital tract is followed. In this manner the reader obtains a unified picture of the disease processes involving the individual segments of the genito-urinary system. The work is presented in an extremely readable style. It is profusely illustrated with excellent photographs, roentgenograms and colored reproductions. The bibliographic references are adequate in number and well chosen. The index at the end of the second volume is carefully arranged. The work should be of great value to all interested in urological matters.

THE THYROID GLAND. By Charles H. Mayo, M.D., Professor of Surgery, University of Minnesota, Mayo Foundation; and Henry W. Plummer, M.D., Professor of Medicine, University of Minnesota, Mayo Foundation. The Beaumont Foundation Lectures, Series Number Four. 12 mo. Pp. 83. St. Louis: The C. V. Mosby Company, 1926.

"Multum in parvo" describes these Beaumont lectures from the Mayo Foundation. Drs. Mayo and Plummer have given the latest word on the thyroid gland in a fascinating and brief exposition. Their experience and ripe judgment is based on a material that dwarfs that of any one else the world over.

LES PROBLÈMES DE LA PHYSIOLOGIE NORMALE ET PATHOLOGIQUE DE L'OS. Par. R. Lèriche, Professeur de Clinique Chirurgicale à la Faculté de Strasbourg; et A. Policard, Professeur d'Histologie à la Faculté de Lyon. 8vo. Pp. 229, illustrated. Paris: Masson et Cie, 1926.

Along with the change in our pathological conceptions which has occurred within the past decade or two, has come increase in interest in the problems concerning the growth and repair of bone. Whereas previously it had been looked upon as a more or less unchanging framework upon which and within which the vital processes went on, it is now rightly considered as itself taking part in the varied processes of metabolism and disease. We have come to look upon bone much in the light of the soft tissues of the body as continually undergoing destruction and restoration and we have consequently arrived at a conception of physiology of bone. The fundamental factors involved in this new physiology have been and still are being described in countless contributions. Until the present the material has been too detailed to permit of an adequate philosophy of bone growth processes. In German a very excellent work by Muller has recently been presented. But while it is characterized by Teutonic thoroughness, it lacks the clarity and terseness which has made the French mind and the French language a model.

The volume by Lèriche and Policard represents the consummation of a decade's collaboration and observation in the physiology of bone. They have carefully reviewed all literature on bone formation, kept those parts of the various theories that coincided with their own experience, and have mercilessly cast out other parts. The result is a supremely interesting, well written monograph dedicated to an explanation of the normal as well as the abnormal facts of bone physiology. In their conception the bone cell *per se* loses its dominating importance in the growth or destruction of bone. The fundamental factors are of a physical-chemical nature, and the bone cell, so far from originating them, is itself subject to these various changes.

The greater part of the work is devoted to a consideration of normal changes occurring either in growing bone or in bone undergoing repair after fracture. One chapter is devoted to an application of the principles previously formulated for pathological phenomena. The book is sparsely illustrated but such sketches and illustrations as are used are well chosen and to the point. The text contains but few references. The appended bibliography, however, is quite complete.

Bernard Heine's Versuche über Knochenregeneration. Sein Leben und Seine Zeit. Bearbeitet durch Dr. K. Vogeler, Assistent der Chirurg. Klinik, Berlin; Dr. H. Walter, Assistant der Chirurg. Klinik, Würzburg; Dr. E. Redenz, Prosektor der Anatomisch. Anstalt, Würzburg; Prof. Dr. B. Martin, Assistent der Chirurg. Klinik, Berlin, 8vo. Pp. 224, with 105 illustrations. Berlin: Julius Springer, 1926.

Some ten years ago, while interested in reviewing his experiences on regeneration of organs and tissues, Bier came upon several references to the work of Heine. A collection of bone specimens was found in the anatomical museum of the University of Würzburg, but the text of his observations and experiments could not be located. After long search, this manuscript was finally unearthed in the archives of the French Academy of Science. It appears that Heine antedated Ollier by some thirty years in his demonstration of the significance of the periosteum and the endosteum in the regeneration of bone.

The present volume contains a short history of Heine's life with a description of the state of knowledge on bone regeneration at that time. The second part consists of an accurate account of Heine's experimental work and a description of the resulting bone specimens. The third section is devoted to a transcription of Heine's communication to the French Academy of Science on the work he had performed. This work is of value as giving due credit to an outstanding figure in medicine and in providing an excellent and accurate historical background against which to project our present knowledge of bone.

Collected Papers by the Staff of the Henry Ford Hospital (First Series); 1915–1925). Cloth. 8vo. Price, $8.00. Pp. 634, with 151 illustrations and 42 charts. New York: Paul B. Hoeber, Inc., 1926.

The staff of the Henry Ford Hospital may well be gratified by this volume of the collected contributions of its first decennium. In spite of interruptions occasioned by the war, it reveals a successful consistent effort to advance the practice and theory of medicine and surgery. Such volumes as this serve the useful purpose of gathering from many scattered journals the literary production of a hospital for appraisal by its staff, its trustees and its sister institutions throughout the world. It offers as well, a gauge of the staff's achievement for prospective internes and others who may seek affiliation with the hospital. As such, this volume "stacks well." There is no outstanding originality but it is a record of sound judgment and of diligence. The publisher has created a beautiful book.

Asthma, Hay Fever, Urticaria and Allied Manifestations of Allergy. By William W. Duke, Kansas City, Mo. Cloth. 8vo. Price, $5.50. Pp. 339, with 75 illustrations. St. Louis: The C. V. Mosby Company, 1925.

This is an excellent book by a keen practical clinician and pioneer. Part I, in sixteen chapters, contains a discussion of experimental anaphylaxis, serum sickness, bacterial allergy, and illness in human beings traceable to specific hypersensitiveness to material agents. Part II discusses reactions caused specifically by action of physical agents, such as light, heat, cold, mechanical irritation, freezing, and burns, and in the case of heat sensitiveness, indirectly by the effect of mental or physical effort. The

subject is one that interests surgeons as well as physicians and this excellent and precise presentation should be given space even in the most carefully selected shelf of books. There is an excellent bibliography. The illustrations and case reports add to the practical value of the volume.

THE INTERNATIONAL MEDICAL ANNUAL. A YEAR BOOK OF TREATMENT AND PRACTITIONER'S INDEX. Cloth. 8vo. Price, $6.00. Pp. 555, illustrated. New York: William Wood and Company, 1926.

The Medical Annual for 1926 presents in its well written introduction a judicial statement of the year's medical achievements. The eminent contributors present not only outlines of the literature but also brief critiques. For forty-four years this index of medical progress has been welcomed by an increasing audience made familiar with medical advance through its fascinating pages of well printed text and illustrations.

HANDBUCH DER BIOLOGISCHEN ARBEITSMETHODEN. Unter Mitarbeit von über 600 bedutenden Fachmännern herausgegeben von Geh. Med.-Rat. Prof. Dr. Emil Abderhalden, Direktor des Physiologischen Institutes der Universität Halle a.d. Saale. Abt. v, Methoden zum Studium der Funktionen der Einzelnen Organe des Tierischen Organismus, Teil 1, Heft 3. 8vo. Pp. 79. Berlin: Urban und Schwarzenberg, 1926.

This little volume gives precise directions for the manufacture and use of thermo-couples for temperature determination, for the maintenance of artificial respiration in laboratory animals, and for perfusion of the spleen. It is a reference volume for the library of a medical school.